ATLANTIC PROVINCES

HOME VEGETABLE GARDENING

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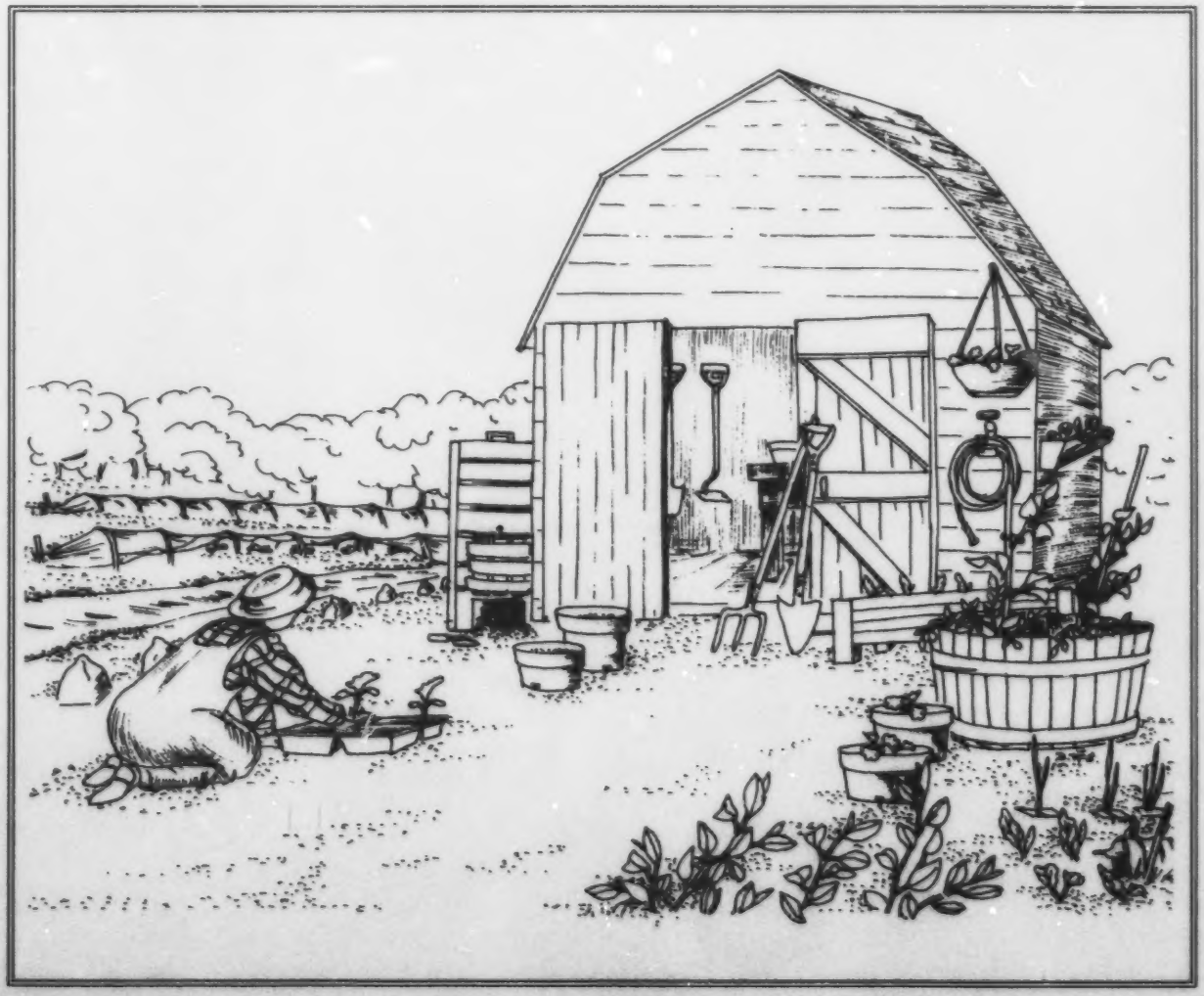


Home Vegetable Gardening
Publication 1440
Table of Contents

HOME VEGETABLE GARDENING 1
- Introduction 1
- Choosing a Site 1
- Garden Plan 1
- Garden Design Principles 4
- Tools and Equipment 11
- Soil Preparation and Planting 12
- Row Establishment 13
- Soil Fertility 14
- Transplants 18
- Water 20
- Weed Control 20
- Season Extension 21
- Companion Planting 23
- Pest Management for Problem Prevention 23
- Pesticide Selection 26
- Insecticides and Fungicides for the Home Garden 26
- Container Gardening 28
- Vertebrate Pests 29

COMMON GARDEN INSECTS 30
- Cutworms 30
- Root Maggots 30
- Seed Corn Maggot 31
- Leaf Miners 31
- Aphids 32
- Slugs 32
- Colorado Potato Beetle 32
- Flea Beetles 33
- European Corn Borer 33
- Corn Earworm 33
- Imported Cabbageworm, Cabbage Looper, Diamond Backed moth, Purplebacked Cabbageworm 34
- Earwigs 34
- Potato Stem Borer 35
- White Grubs 35
- Onion Thrips 35
- Spider Mites 35
- Fall Armyworm 35
- Wireworms 36
- Cucumber Beetle 36
- Asparagus Beetle 36
- Beneficial Insects 36

COMMON DISORDERS 38
- Blossom End Rot of Tomatoes, Blackheart of Celery 38
- Boron Deficiency 38

COMMON DISEASE PROBLEMS 39
- Early Blight 39
- Late Blight 39
- Clubroot 39
- Damping Off 39
- Anthracnose 40
- White Mold, Gray Mold 40
- Powdery Mildew 40
- Downy Mildew 41
- Scab 41

Key to Identify Adult Stage of Insect Pests 42

Key to Identify Larva Stage of Insect Pests 44

Suggested Reading 46

Home Vegetable Gardening

Introduction

Gardening is an enjoyable and educational pastime for many people. Besides supplying you with fresh wholesome vegetables it also provides fresh air, exercise, and an escape from daily pressures. Garden size can range from a few containers on the patio, to a few vegetables interplanted in the flower beds, or to a backyard garden that supplies the entire neighborhood with the quantity required for fresh consumption and storage. However, a small garden well tended often yields more vegetables and satisfaction than a larger one poorly tended.

Choosing a Site

Ideally, the garden should receive as much sunlight as possible as most vegetables require at least 5 or 6 hours of direct sunlight per day. Excessive shading can cause spindly growth and reduced yields of heat loving crops such as tomatoes, peppers and cucumbers. Some insect and disease problems can be more serious in shady gardens. As well, tree roots will compete for moisture and nutrients. If shaded areas must be used, crops such as beets, carrots, kale, lettuce, peas and spinach can be grown as they tolerate shade.

If possible, the garden should be close to the house for convenience and for protection from birds and wildlife. Close proximity to the water supply is also an advantage. The site should be level or slightly sloped to ensure adequate drainage. Steep slopes should be avoided to prevent soil erosion. However, if a slope is the only available location, terracing may be used to correct severe situations.

A good garden soil should be friable and porous for quick water drainage, root penetration, and good aeration. It should be fertile, high in organic matter, and have a pH level of 6.0 to 6.8. A deep fine sandy loam or silt loam soil is ideal. Soils which contain too much sand will drain quickly but will not hold the soluble nutrients required for plant growth in the root zone. A heavy clay soil will hold nutrients and water but will offer poor aeration and may become water logged. Few vegetables can tolerate "wet feet" for long periods of time as the oxygen required for life is not available to the roots.

If the available garden soil does not fit this criteria, applications of organic materials, lime, and fertilizer can do a lot to open up a poor soil and make it productive. Well rotted manures can be applied in the raw state. Other materials such as leaves, sawdust, kelp-like seaweeds, kitchen wastes, grass clippings, and plant debris should be composted before application. Mulches and green manure crops will also build up the soil to a more productive state. It may take a few years but the effort is well worth it.

Sites to avoid include areas composed of "fill dirt", low areas, and wet spots with poor drainage. Fill usually consists of subsoil, rocks, and debris and is low in fertility. Only through time, numerous additions of organic matter and a considerable amount of effort can such areas be made productive.

Garden Plan

Planning for the gardening season can begin as soon as the seed catalogue arrives. Early planning will allow time to determine the quantity of seed and supplies required for the gardening season. Whether gardening conventionally or organically, every gardener can benefit from a written garden plan outlining crops to be produced, fertility requirements, crop locations and planting dates. Once prepared, the plan should be kept from year to year for crop rotation and soil fertility management purposes.

The plan can be as simple as a list of vegetables to be grown and their growth requirements, to a detailed map of the garden drawn to scale. Whatever form the plan takes, begin with a basic consideration of the crops to be produced using the following criteria:

- ***Personal preferences:*** plant what family members like to eat.
- ***Continuity of supply.*** One of the most frequent problems for the beginner gardener is having large quantities of one vegetable ready for harvest all at once. This can be avoided by choosing varieties that have different maturity dates. In the seed catalogue, these are identified by the terms 'early', 'mid-season' and 'late maturing'. Staggering planting dates will also help to avoid the problem.
- ***Quantity:*** Decisions on this parameter are based on the end use of the crop, which may be fresh consumption, preserves, freezing or other types of storage for winter consumption.
- ***Space requirements and growth habit of each crop.*** The growth habit of the crop determines how much space is needed for each plant within a row and between rows. Space available may restrict the crops to be produced. Based on total food yield per plant, crops such as winter squash and corn may be unsuitable for small gardens. Tomatoes, summer squash, cole crops, snap beans, leafy vegetables, carrots and beets are much more space efficient.
- ***Seasonal requirements of the crop:*** the length of the growing season and the climatic conditions during the season influence your choice of crops. Compared to other regions of eastern North America, Atlantic Canada is relatively cool. Therefore, some crops, such as melons, eggplants and sweet potato are difficult to grow in this region as they require a longer growing season and warmer conditions than we experience. The regional variations in growing season are summarized. See Climate Maps.
- ***Disease and pest resistance and tolerance:*** These qualities are indicated in the variety descriptions found in seed catalogues and should be noted particularly if you are planning to avoid using pesticides.

Upon consideration of these criteria, and selection of the vegetable to be grown, the garden plan can be prepared. Tables 1 and 2, Appendix, provide information on expected yields, meters of row to plant per person, and crop seed and space requirements which will help in the preparation of a plan for maximum space efficiency.

TABLE 1

HOME GARDEN VEGETABLE PLANTING GUIDE

VEGETABLE	Seed req'd / 10 m row (grams)	Distance between rows (cm)	Distance between plants (cm)	Planting depth (cm)
Asparagus	8-10 crowns	125-175	30-50	20-25
Beans				
green	150	60	5-10	4-5
wax	150	60	5-10	4-5
pole	80	60-90	15-20	4-5
dry	80	60-90	8-13	4-5
broad	375	60-90	7-15	4-5
Beets				
early	15	45-60	2-7	1.5
main crop	15	45-60	2-7	1.5
Broccoli	5	60-75	45-60	.5-1.5
Brussels Sprouts	5	60	30-50	.5-1.5
Cabbage				
early	5	60-75	25-40	.5-1.5
main	5	60-75	30-50	.5-1.5
storage	4	60-75	35-60	.5-1.5
Carrots	5	45-60	3-5	1.5
Cauliflower				
early	5	60-75	40-50	.5-1.5
late	5	60-75	45-60	.5-1.5
Celery	1 pkt.	60-90	15-20	.3
Chard, Swiss	10	60	10-30	1.5
Chinese cabbage	5	60-75	20-30	.6
Corn, Sweet	50	75-90	15-25	2.5
Cucumbers	5	120-150	30-60	1.5-2.5
Garlic, white	400 cloves	5-8	8-15	1.5-3.0
Gourds	5	100-200	20-30	1.5-2.5
Eggplant	1 pkt.	60	60	1.5
Kale	5	70	15-20	.5
Kohlrabi	5	60	10-15	1.5-2
Leek	5	60	10-15	1.2
Lettuce				
leaf	4	45-60	15-30	.5-1.0
head:				
iceburg	4	45-60	20-30	.5-1.0
butter	4	45-60	20-30	.5-1.0
cos	4	45-60	20-30	.5-1.0
Muskmelon	5	120	20-30	1.5-2.5
Onion				
seeded:				
yellow	~	45-60	5-8	1.5-3.0
red	~	45-60	5-8	1.5-3.0
white	~	45-60	5-8	1.5-3.0
transplants:				
spanish	5	45-60	10-15	1.5-3.0
bunching	9	45-60	3-5	1.5-3.0
sets	300	45-60	5-10	1.5-3.0
Parsley	5	45-60	5-10	.5-1.0
Parsnip	~	45-90	5-10	1.5
Peas				
bush	200	45-90	3-8	2.5-5
leafless	200	45-90	3-8	2.5-5
freezing	200	45-90	3-8	2.5-5
canning	200	45-90	3-5	2.5-5
edible pod	150	45-90	3-8	2.5-5
pole	100	45-90	5-8	2.5-5
Peppers	1 pkt.	60	40-50	1.5
Potatoes	2.5kg	75-90	25-30	10
Pumpkin	8	180-250	30-80	2.5
Radish	8	30	3	1.2
Rhubarb	15 crowns	90	60-120	bury to top of crown
Rutabaga	5	45-60	10-15	.5-1.5
Turnip	5	45-60	8-13	.5-1.0
Spinach				
spring	10	5-13	30-45	1.5-2.5
fall	10	5-13	30-80	1.5-2.5
Squash				
summer	8	180-250	30-45	2-3
winter	8	180-250	30-80	2-3
Tomatoes	1 pkt.	90	45-80	1.2
Watermelon	8	120-180	45-80	2-3

TABLE 2

Crop	Yield per 10m of row	Meters of row per person	Days to Harvest	Storage Period (weeks)	Temp (°C)	Humidity (%)
Asparagus	200 spears	9	Spring 3rd year	3-4	0.0	95
Beans						
green	8kg	6.75	60-70	1-2	7-10	85-90
wax	8kg	6.75	60-70	1-2	7-10	85-90
pole	15kg	4.5	70-90	1-2	7-10	85-90
dry	1.5kg	3-5	90-110	52	7-10	household
broad	5 to 7kg		70-80	2	7-10	85-90
Beets						
early	150 roots	10	60-80	2-3	0.0	90-95
late	150 roots	10	70-80	4-12	0.0	90-95
Broccoli						
early	8kg	8.5	70-90	1-2	0.0	90-95
late	8kg	8.5	70-90	1-2	0.0	90-95

TABLE 2 cont'd

Crop	Yield per 10m of row	Meters of row per person	Days to Harvest	Storage Period (weeks)	Temp (°C)	Humidity (%)
Brussels Sprouts	8kg	6.0	80-100	3-6	0.0	90-95
Cabbage						
early	16 head	4.5	65-75	3-4	0.0	90-95
main	16 head	4.5	75-85	10-15	0.0	90-95
storage	16 head	4.5	85-110	12-16	0.0	90-95
Carrots	170 roots	9	80-100	10-20	0.0	95
Cauliflower						
early	20 heads	4.0	50-100	2-3	0.0	90-95
late	16 heads	4.5	80-100	3-4	0.0	90-95
Celery	60 plants	5.0	100-120	10-12	0.0	95 +
Chard, Swiss	33 plants	4.5	60-65	1-2	0.0	90-95
Chinese Cabbage	33 heads	4.5	70-80	4-8	0.0	90-95
Corn, Sweet						
early	45 ears	9	60-75	< 1	0.0	90-95
main	40 ears	9	85-100	< 1	0.0	90-95
Cucumbers						
slicing	18kg	4.5	55-60	1-2	10	95
pickling	18kg	4.5	90-110	1-3	10	95
Garlic	8kg	3.0	90-100	30-45	0.0	70-75
Gourds	100 fruit	non-edible	100			
Eggplant	65 fruit	4.5	80-90	1-2	10	85-90
Kale	16 plants	1.5	50-60	1-2	0.0	90-95
Kohlrabi	100 head	1.5	50-60	2-4	0.0	90-95
Leek	60 stems	1.5	100	4-12	0.0	90-95
Lettuce						
leaf	65 heads	4.5	45-50	2-3	0.0	95
head						
iceberg	40 heads	4.5	70-80	2-3	0.0	95
butter	40 heads	4.5	50-65	2-3	0.0	95
cos	40 heads	4.5	50-65	2-3	0.0	95
Muskmelons	30 fruit	4.5	80-90	2-3	7.0	85-90
Onions						
Seeded						
yellow	125-200 bulbs	9	100-110	12-32	0.0	50-70
red	125-200 bulbs	9	100-110	12-32	0.0	50-70
white	125-200 bulbs	9	100-110	12-32	0.0	50-70
Transplant						
spanish	65-100 bulbs	4.5	120-140	12-32	0.0	50-70
bunching	250 tops	1.5	60-70	1-2	0.0	50-70
Sets	125-200 bulbs	9	50-70	12-32	0.0	50-70
Parsley	100 bunches	1.5	80-90	1-2	0.0	90-95
Parsnip	50-100 roots	4.5	130-140	8-16	0.0	95
Peas						
bush	7-9kg	5	60-70	1-2	0.0	95
leafless	7-9kg	5	60-70	1-2	0.0	95
freezing	7-9kg	5	75-80	1-2	0.0	95
canning	7-9kg	5	60-70	1-2	0.0	95
edible pod	7-9kg	5	60-70	1-2	0.0	95
pole	7-9kg	5	75-80	1-2	0.0	85
Peppers	75-100 fruit	2-3	70-80	1-2	10	85-90
Potatoes						
early	20-30kg	9	80-90	1-3	10	85-90
storage	30kg	9	110-120	12-48	3.9	85-90
Pumpkins	50-60	1.5	90-100	8-12	10	70-75
Radish	330 roots	1.8	21-25	1-2	0.0	90-95
Rhubarb	100 stalks	4.5	2years	2-3	0.0	90-95
Rutabagas	80 roots	2	90-100	12-50	0.0	90-95
Turnip	100 roots	1.5	50-60	6-8	0.0	90-95
Spinach						
spring	75 plants	4.0	45-50	1-2	0.0	90-95
fall	75 plants	4.0	45-50	1-2	0.0	90-95
Squash						
summer	65 fruit	4.5	50-75	1-2	10	70-75
winter	85 fruit	1.5	75-110	8-52	10	70-75
Tomatoes						
unstaked	50kg	10	80-100	2-4	10	85-95
staked	50kg	10	80-100	2-4	10	85-90
Watermelon	30 fruit	4.5	80-100	2-3	5	85-90

Garden Design Principles

Once you have decided upon the crops to be grown, the garden can be designed using a number of general principles.

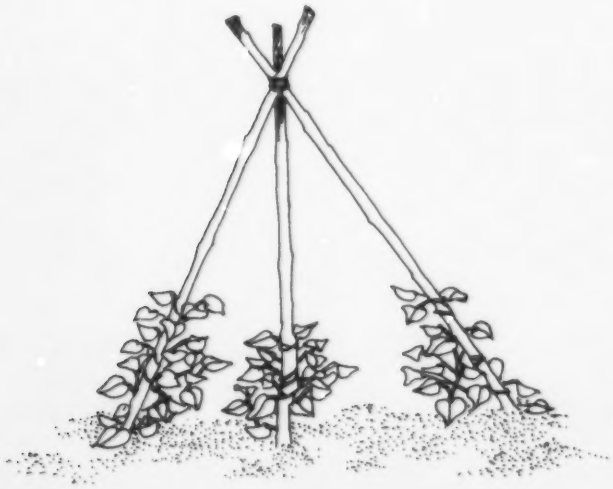
- Crop rotation should be practiced in every garden. Many insects and diseases which cause problems overwinter in the soil and populations can build up rapidly in the soil if provided with a suitable host each year. Rotation should be by family as well as by individual crops. For example, plant cole crops after members of the Solanaceae (potatoes, tomatoes). Two to three years is the maximum time period for crop families to be planted in the same garden area. Soil nutrient depletion or imbalance can also result from replanting of the same crop family in the same area. See Table 3 for groupings of vegetables which belong to the same crop families.

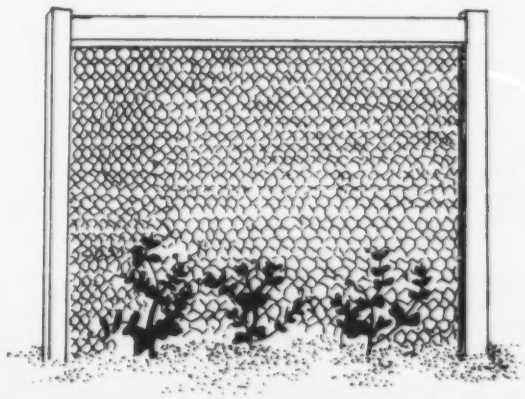
TABLE 3

VEGETABLES WHICH BELONG TO THE SAME FAMILY

Cruciferae	**Cucurbitaceae**	**Compositae**
Broccoli	Cucumber	Endive
Brussels Sprouts	Gourds	Globe Artichoke
Cabbage	Muskmelon	Jeruslem Artichoke
Cauliflower	Pumpkin	Lettuce
Kale	Squash	Radicchio
Kohlrabi	Watermelon	
Radish		
Rutabaga		
Turnip		
Solanaceae	**Chenopodiceae**	**Leguminasae**
Eggplant	Beets	Beans
Pepper	Chard,Swiss	Lentils
Potato	Spinach	Peas
Tomato		
Amaryllidaceae	**Umbelliferae**	
Garlic	Carrot	
Leek	Celery	
Onion	Fennel	
	Parsley	
	Parsnips	

- If space allows, divide the garden into two equal sections and alternate vegetable production between the sections from year to year. The non-vegetable producing section can be either planted with a green manure crop to increase organic matter content of the soil, or summer fallowed for weed control purposes.
- The garden rows can run either north and south or east and west. A north and south orientation will take the best advantage of the available sunlight but an east and west orientation may be required on sloping land to prevent erosion. Should an east and west orientation be necessary, plant the tall crops on the north side of the garden to reduce shading. Then group crops according to height, planting back to front (tall crops at the back) to avoid shading.
- Perennial crops, such as asparagus, rhubarb, or small fruit crops should be placed at the edge of the garden to simplify land preparation in the spring.
- Short season, rapidly growing crops can be grouped together for two separate garden design purposes. If the technique of successive cropping is to be incorporated into the garden design, intermittent planting can be most easily maintained within a specific region of the garden. If only one planting of short season crops is planned, the technique of double cropping can be incorporated into the garden design to improve space efficiency. This technique involves the planting of short season crops in the same row as (radish with carrots), or adjacent row to (lettuce or radish beside squash or pumpkins), longer season crops. This technique can be used in both direct seeded and transplanted crops and in both wide-bed and single row type gardens.
- Productivity of a small garden can be increased by going vertical wherever possible. Natural climbers such as peas, pole beans, and vine crops can be easily grown on a trellis system. Vine tomatoes can be staked.
- Variety selection of the crops to be grown in the garden can be made based on the following guidelines:





- Purchase seeds from local seed companies which specialize in varieties recommended for your region.
- Check the package for germination percentage.
- Check the variety description for disease resistance or tolerance. A variety which is resistant has the ability to resist infection by a disease organism. A tolerant variety is susceptible to a disease organism and can be infected. It will however, not be killed by the organism and is able to produce a good crop.
- Select varieties which will grow within the climatic conditions of the region. See Climate Maps pages 9 and 10.
- Select varieties which suit the space allocation for each crop. Bush varieties of summer squash and tomatoes are more compact than standard varieties and will save space in a small gardening area.
- Some garden plans are illustrated on pages 6-8.
- The ability of each vegetable to withstand cool temperatures and frost is known as the hardiness or cold tolerance of the crop (Table 4). This must be taken into consideration when designing the garden as the hardiness determines whether a vegetable can be direct seeded or must be grown from transplants. Seed and transplant requirements are listed in Table 1 and planting times are summarized in Table 5.

TABLE 4

COOL AND WARM SEASON CROPS

COOL SEASON VEGETABLES:		
Beets	Collards	Parsley
Broccoli	Dill	Parsnip
Brussels Sprouts	Kale	Peas
Cabbage	Kohlrabi	Potatoes
Carrots	Leek	Radish
Cauliflower	Lettuce	Rutabaga
Chard,Swiss	Onion	Spinach
Chinese vegetables	Turnip	
WARM SEASON VEGETABLES:		
Beans	Okra	Squash
Cucumbers	Peppers	Sweet Corn
Eggplant	Pumpkins	Sweet Potatoes
Melons	Tomatoes	

TABLE 5

PLANTING TIME FOR VEGETABLES BY FROST TOLERANCE OF EACH CROP

4 -6 weeks Before last frost	2-4 weeks Before last frost	On frost-free date	Crops suitable for succession
			mid-June
Broccoli*	Beans	Celery*	Beans
Brussels Sprouts*	Beets	Cucumbers	Cabbage*
Cabbage*	Cauliflower*	Eggplant*	Carrots
Carrots	Chard, Swiss	Melons*	Corn
Early Potatoes	Corn	Peppers*	Lettuce*
Leek*	Dill	Pumpkins*	Radish
Lettuce*	Parsnips	Squash, summer*	
Onion	Potatoes	Squash, winter*	**early/mid July**
Parsley		Tomatoes*	Beets
Peas			Broccoli*
Radish			Cauliflower*
Spinach			Lettuce*
Turnip & Rutabaga			Kale*
			late July
			Beets
			Broccoli*
			Lettuce*
			Peas
			Radish
			Spinach

* transplants

- Row type is something about which you have a choice, but one that must be made as you plan the garden. Although most gardeners still plant on the flat in narrow, single rows, the use of wide rows and/or raised beds are becoming increasingly popular. Permanent raised beds are either free standing or protected by supporting walls. The advantages over the standard garden design include greater soil depth, excellent drainage and aeration, earlier warming in the spring, better soil structure due to less foot traffic, greater ease of soil fertility management and easier weed control. Properly managed raised beds are high yielding and therefore an excellent choice for small gardens. The actual width of raised beds and number of rows planted on a raised bed will vary by bed type and crop grown. In general, the center of the bed should be within easy reach of either side of the bed. The use of a bed system with two or more rows close together and a walk way between each bed is also a space saving technique as well as an excellent way to reduce soil compaction caused by excessive foot traffic. Additionally, double cropping and succession planting are highly effective in raised and/or wide-bed gardening.
- The nutritional requirement of each vegetable crop is important in crop placement within the garden. Crops are either light, medium or heavy feeders (Table 6) as well as being either shallow, moderate, or deeply rooted (Table 7). Because of these two factors, nutrients required for growth are required in different quantities and are obtained from different regions of the root zone by the various crops. Keeping these

factors in mind are important for intercropping and double cropping to reduce competition for available nutrients.

- The nutritional requirements and rooting characteristics of vegetable crops is also an important consideration in permanent, wide-bed or organic vegetable gardening. For either gardening method, the soil should be brought to the best possible condition before the initial gardening year with applications of lime for pH adjustment and organic matter or other plant nutrient containing materials. Begin the initial crop rotation with a heavy feeder followed by a moderate feeder and then one to two years of light feeders. Before returning to a heavy feeder, put the garden into a green manure crop for one year or apply an extra heavy application of compost or well rotted manure. In subsequent years, apply only the minimal application of plant nutrients required to maintain soil nutrient levels.

Three Year Garden Plan/Crop Rotation
North-South Row Orientation

YEAR ONE

Asparagus	Rhubarb
Sweet Corn	
Pumpkin, Winter Squash	
Cucumbers	
Brussels Sprouts	Rutabagas
Carrots	Parsnips
Beans (green, wax)	
Muskmelon	Herbs
Watermelon	Herbs
Cabbage	
Tomatoes, Peppers	
Trellised Pole Beans	
Trellised Peas	
Cauliflower	
Broccoli	Celery
Broccoli	Eggplant
Beets	
Onions, Garlic	
Potatoes	
Turnips	Head Lettuce
Chard, Swiss	Kohlrabi
Radish	Spinach
Leaf Lettuce	Broccoli

YEAR TWO

Asparagus	Rhubarb
Leaf Lettuce Radish Chard, Swiss Kohlrabi	Spinach Broccoli Head Lettuce Broccoli
Potatoes	
Trellised Pole Beans	
Trellised Peas	
Cauliflower	
Beets	
Beans	
Onions, Garlic	
Herbs	
Cabbage	
Carrots	Parsnips
Muskmelon	Water Melon
Eggplant	Broccoli
Celery	Broccoli
Tomatoes Peppers	
Brussels Sprouts Rutabagas	
Cucumbers	
Pumpkins, Winter Squash	
Sweet Corn	

Three Year Garden Plan/Crop Rotation
North-South Row Orientation

YEAR THREE

Asparagus	Rhubarb
Potatoes	
Sweet Corn	
Pumpkins, Winter Squash	
Leaf Lettuce Spinach Kohlrabi Turnips	Head Lettuce Radish Chard, Swiss Broccoli
Herbs	
Cauliflower	
Beets	
Broccoli	
Beans	
Cucumbers	
Muskmelon	Watermelon
Carrots	Parsnips
Trellised Peas	
Trellised Pole Beans	
Cabbage	
Onions Garlic	
Celery	Eggplant
Brussels Sprouts	Rutabagas
Tomatoes	Peppers

Three Year Garden Plan/Crop Rotation
East - West Row Orientation

YEAR ONE

Sweet Corn	
Trellised Pole Beans	
Trellised Peas	
Peppers Tomatoes	
Muskmelons Watermelons	
Brussels Sprouts	Rutabagas
Pumpkins, Winter Squash	
Cucumbers	
Potatoes	
Cabbage	
Onions Garlic	
Beans (green, wax)	
Kohlrabi	Head Lettuce
Zucchini	Chard, Swiss
Cauliflower	
Carrots	Parsnips
Herbs	
Broccoli	
Beets	
Turnips	Spinach
Leaf Lettuce	Radish
Rhubarb	Asparagus

Three Year Garden Plan/Crop Rotation
East - West Row Orientation

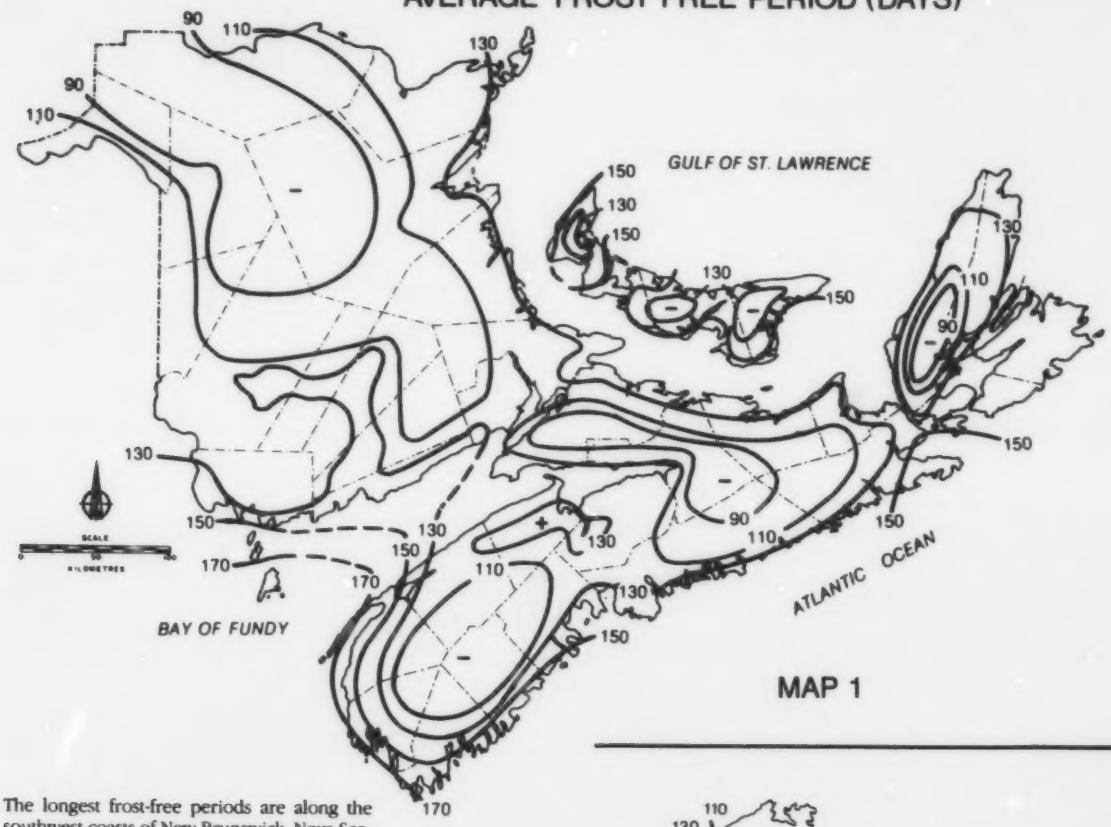
YEAR TWO

Pumpkins, Winter Squash	
Trellised Pole Beans	
Sweet Corn	
Trellised Peas	
Tomatoes, Peppers	
Carrots	Parsnips
Head Lettuce	Kohlrabi
Onions	Garlic
Rutabagas	Brussels Sprouts
Beets	
Cucumbers	
Muskmelon	Watermelon
Zucchini	Turnips
Cabbage	
Beans (wax, green)	
Cauliflower	
Spinach	Chard, Swiss
Herbs	
Broccoli	
Leaf Lettuce	Radish
Potatoes	
Rhubarb	Asparagus

YEAR THREE

Trellised Pole Beans	
Trellised Peas	
Pumpkins, Winter Squash	
Potatoes	
Sweet Corn	
Brussels Sprouts	Rutabagas
Carrots	Parsnips
Onions	Garlic
Cabbage	Beans (green)
Cabbage	Beans (wax)
Beets	
Cauliflower	
Cucumbers	
Tomatoes	Peppers
Head Lettuce	Broccoli
Turnips	Kohlrabi
Zucchini	Spinach
Watermelon	Chard, Swiss
Muskmelon	Radish
Leaf Lettuce	Herbs
Spinach	Herbs
Rhubarb	Asparagus

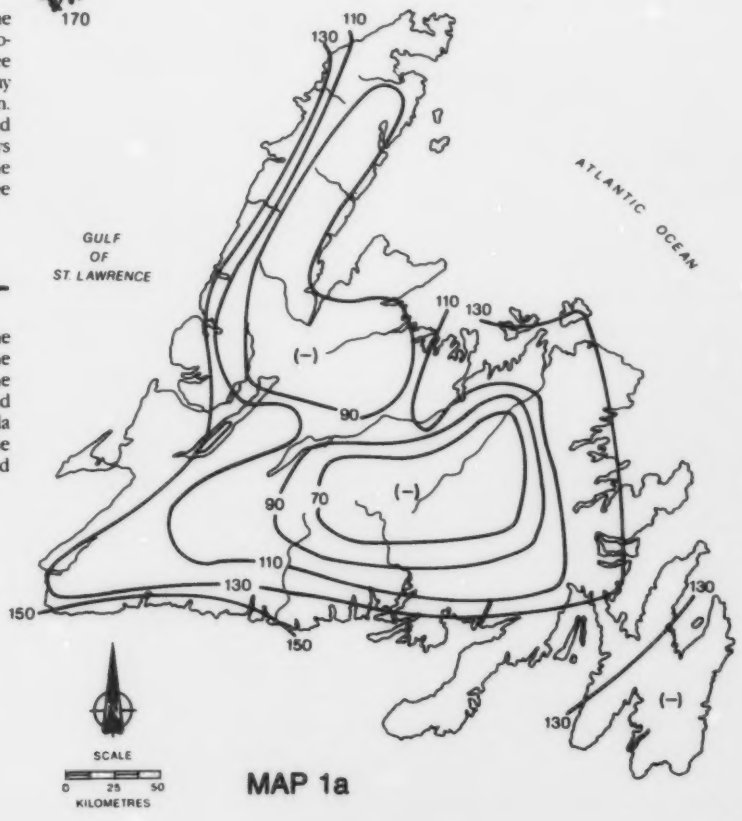
AVERAGE FROST FREE PERIOD (DAYS)



MAP 1

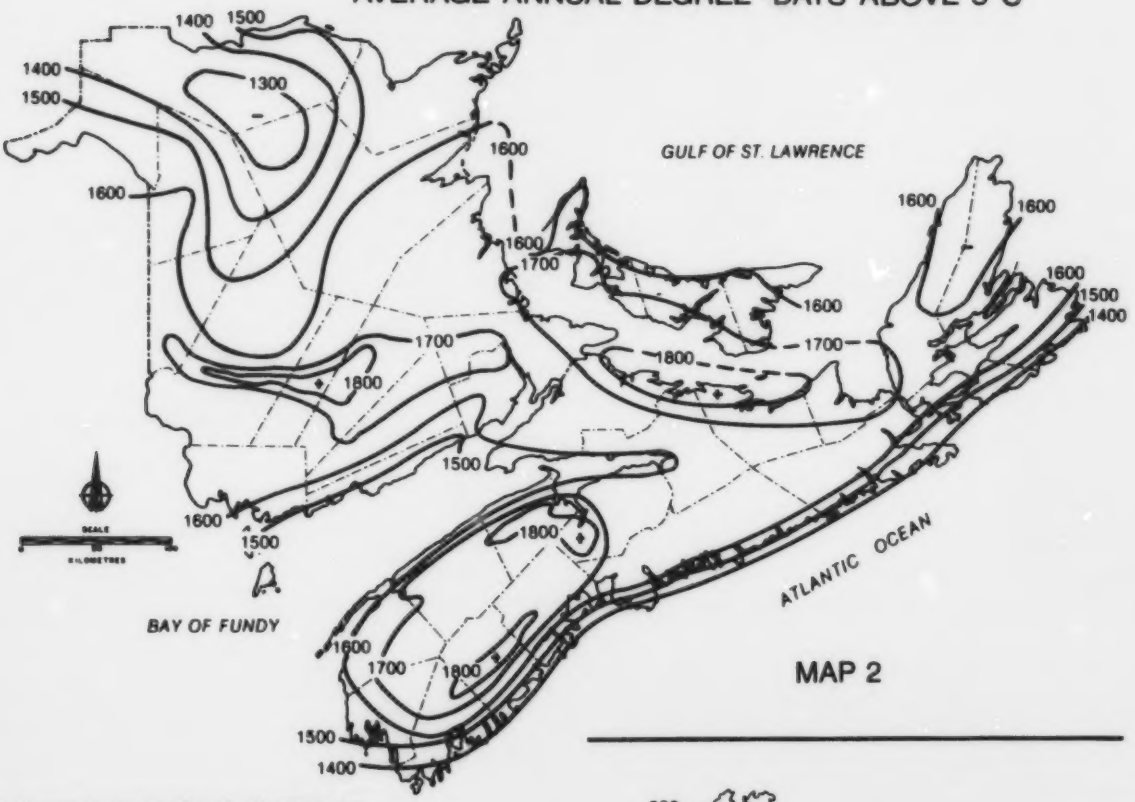
The longest frost-free periods are along the southwest coasts of New Brunswick, Nova Scotia and Prince Edward Island. The frost-free period decreases rapidly with distance away from the moderating influence of the ocean. The coastal area along the Northumberland Strait has a frost-free period of about 130 days very near the water. Inland areas and the higher elevations have the shortest frost-free periods.

The longest frost-free period is along the south coast from Burgeo to Cape Ray. The next shortest frost-free period is along the south, west and east coasts. Inland areas and the eastern part of the Northern Peninsula have the next shortest frost-free period. The interior of the province has a frost-free period of only 70 days.



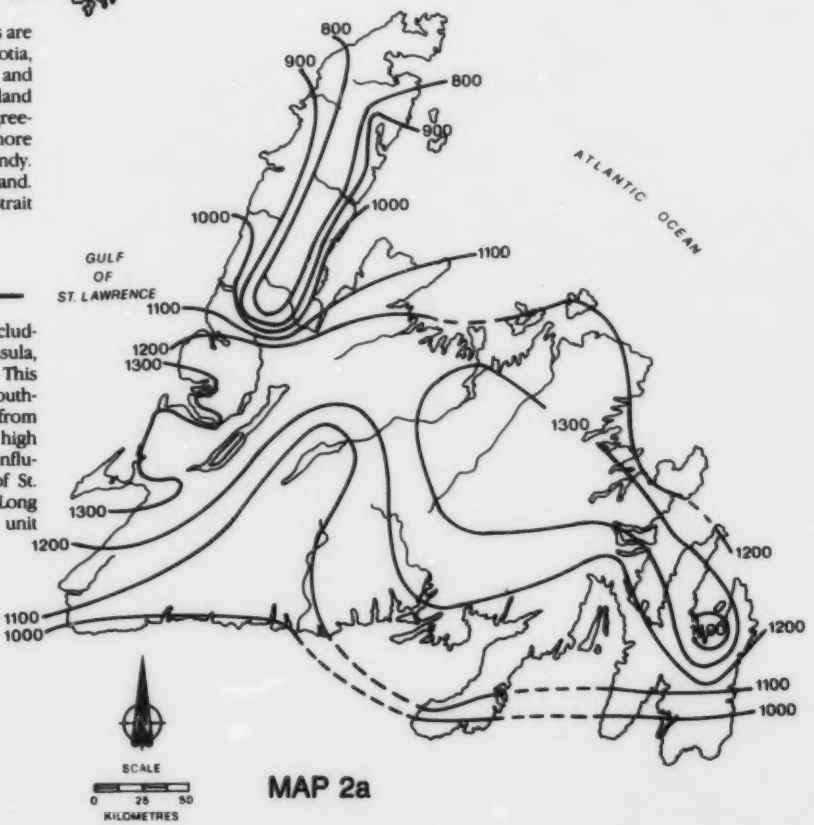
MAP 1a

AVERAGE ANNUAL DEGREE-DAYS ABOVE 5°C



MAP 2

The largest heat unit totals in the Maritimes are found in the Annapolis Valley of Nova Scotia, the Grand Lake area of New Brunswick, and the coastal area along the Northumberland Strait. Cold Atlantic waters reduce degree-day totals along the south and eastern shore of Nova Scotia and along the Bay of Fundy. This influence decreases with distance inland. The warm waters of the Northumberland Strait keep the adjacent Coastal areas warm.



MAP 2a

The northeast part of Newfoundland, including the northern part of the Avalon peninsula, has the most heat units in the province. This area is sheltered from the prevailing southwesterly winds. A narrow coastal strip from Corner Brook to Stephenville also has high heat unit totals, in this case due to the influence of the warm waters of the Gulf of St. Lawrence. The high elevations of the Long Range Mountains have the lowest heat unit totals. Most coastal areas have low heat units.

TABLE 6

VEGETABLE NUTRIENT REQUIREMENTS

HEAVY	MODERATE	LIGHT
Asparagus	Beets	Beans
Broccoli	Carrots	Herbs
Brussels Sprouts	Chard,Swiss	Parsley
Cabbage	Cucumber	Peas
Cauliflower	Eggplant	Radish
Celery	Garlic	Rutabagas
Corn	Kohlrabi	Turnips
Onions	Leek	
Parsnips	Lettuce	
Potatoes	Muskmelons	
Rhubarb	Peppers	
	Pumpkins	
	Squash	
	Watermelon	

TABLE 7

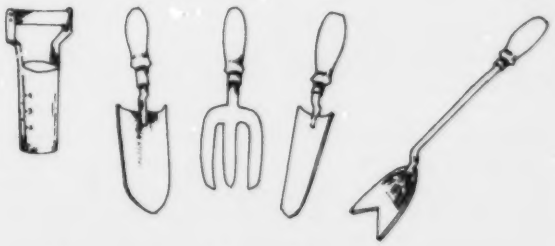
CHARACTERISTIC ROOTING DEPTH OF VEGETABLE CROPS

SHALLOW	MODERATELY DEEP	DEEP
Broccoli	Beans,bush	Asparagus
Brussels Sprouts	Beans,pole	Beans,lima
Cabbage	Beet	Parsnip
Cauliflower	Carrot	Pumpkin
Celery	Chard,Swiss	Squash,winter
Chinese Cabbage	Cucumber	Tomato
Corn	Eggplant	Watermelon
Garlic	Muskmelon	
Leek	Pea	
Lettuce	Pepper	
Onion	Rutabaga	
Parsley	Squash,summer	
Potato	Turnip	
Radish		
Spinach		

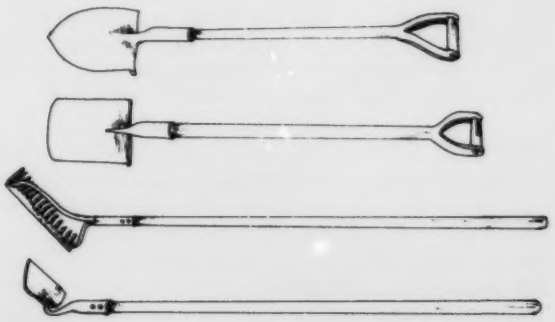
- Placement of crops within the garden is important for the control of disease and insect problems. Problems can be reduced by separating crops, such as tomatoes, eggplant, peppers, and potatoes, which attract the same insect and disease problems (Table 3). The use of companion planting for insect control, attraction of beneficial insects and improved crop growth should be considered when planning crop placement.
- The use of mulches, either organic or synthetic should also be considered when designing the garden. Mulches help to conserve soil moisture, aid in weed control, keep crop clean, and if organic, provide organic matter and nutrients to the soil. Synthetic mulches, such as black plastic also warm up the soil, increase yields, and make possible the production of warm season crops including melons, eggplants and peppers.

Tools and Equipment

The selection of tools and equipment for the home garden can vary depending upon the size of the garden and personal preference. In general, a few tools are basically essential and include a hoe, a rake, a spading fork and a spade or round-pointed shovel. Hand tools which are very useful in the vegetable garden include trowels, a hand rake and fork, a bulb planter (for cutting through plastic mulch), and a Daisy grubber or asparagus fork. Other items which a helpful to have around include a watering can or garden hose and sprinkler nozzles, stakes and twine for marking rows, a yard stick or measuring tape, a sprayer and/or duster, and a wheelbarrow or garden cart. The type of sprayer will vary with the size of garden. Types include hand-operated pump sprayers, hose-end sprayers, and compressed air hand-held or backpack models.



For large gardens, a rototiller or garden tractor may be required. Two types of rototillers are available, smaller, light horse-powered, front tine, and heavier, more powerful rear-tine models. They are useful for soil and seed-bed preparation and between-row cultivation for weed control. The versatility of rear-tine models can be increased by such attachments as furrowers, hillers, and cultivators. Some caution however is required in the use of rototiller. The cultivation of a wet soil or too frequent cultivation can result in the formation of a hardpan. This is a layer of hard-packed soil which forms at the bottom of the working depth of the tines and is impermeable to roots and reduces drainage. Rototillers work the soil to a fine, fluffy mass. This increases the oxidation rate of the organic matter of the soil and can lead to a reduction in the level of organic matter in the soil. If rototilling is a frequent practice, add additional organic matter to the soil on a regular basis.



The investment in garden tools need not be great. However, good quality tools, properly cared for, will provide years of service. Remove the soil after each use. Keep tools sharp and free of rust and store in a dry location under protection from the elements. Hang tools to prevent injury to both the tools and the gardener. Clean rusted tools with steel wool or rust remover and wipe with an oily rag when storing for any period of time.

Soil Preparation and Planting

Soil preparation should begin in the fall. Plant debris should be removed as crops are harvested to reduce overwintering of pest problems. Debris can be incorporated into the compost pile. Diseased plant tissue, however, should be avoided as frequently, home compost piles do not reach adequate temperatures for sufficient lengths of time to destroy disease organisms or overwintering insect pests.

Fall Cultivation

If your garden is large, exposed and on a slope, fall cultivation is not a recommended practice as the soil is left bare, and thus more susceptible to winter erosion. However, under some circumstances fall cultivation is necessary. Slow release fertilizers such as rock phosphate should be applied in the fall to allow time for breakdown and nutrient availability. Lime application for soil pH adjustment, is also more effective if completed in the fall. Manures and other organic amendments should also be applied and incorporated in the fall.

Incorporation of manures is important to ensure that nutrients are not lost to the atmosphere or washed away by the rain or snow. Fall incorporation also encourages breakdown and provides for greater availability of soil nutrients for the following gardening season.

Fall cultivation also helps the soil to warm up more quickly the following spring. If the garden is located in a flat or sheltered location, and an early planting of hardy salad greens is planned, fall preparation of part of the garden is desirable.

If fall cultivation cannot be avoided on an erosion susceptible site, try not to leave the soil completely bare. Rough cultivation which leaves portions of plant material sticking up will trap snow and ensure snow cover for the winter. Mulching materials such as straw or seaweed applied but not incorporated will provide excellent cover. Fall planted crops such as ryegrass, fall rye, or oats also provide excellent cover, prevent the leaching of nutrients, and build the organic matter content of the soil. To be most effective, cover crops should be planted before the end of September.

Organic Matter

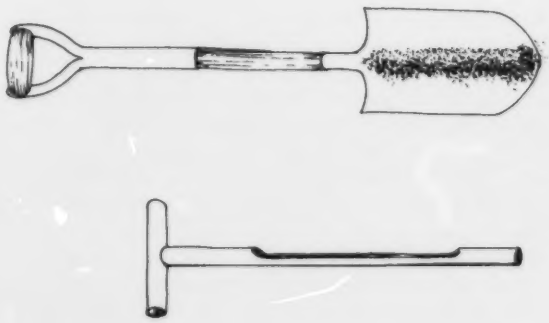
Organic matter content and its maintenance is important to any soil for both structure and fertility. Structurally, organic matter plays an important role in the holding together of soil particles to form a crumb-like structure. Therefore, it improves the water and nutrient holding capacity of sandy soils while it reduces compaction and improves drainage and aeration of heavy clay soils. Organic matter is also important for soil fertility as plant nutrients are released during decomposition. It can also reduce the potential effects of over fertilization or loss of nutrients by leaching as organic matter absorbs nutrients.

The organic matter content of the soil is also important for organic gardening to ensure adequate nutrients for crop growth. Yearly applications of organic matter and rock powder amendments can be applied to build up a balanced reservoir of nutrients in the soil. This however, takes time and may require a few years during which, yearly soil samples can be taken to monitor the progress. Once established, additional yearly applications of organic materials will maintain crop nutritional requirements.

Soil Sampling

Fall is the best time to take a soil sample as both nutrient and soil pH levels are the most stable. Also, if adjustments are required in the pH level, organic matter content, or for organic gardeners, soil nutrient content, sufficient time is available for the required materials to be applied and to become active within the soil.

The sample should be representative of the entire garden area. It should be collected from 10-15 locations throughout the garden, and be collected from the top 15 cm of soil. Soil tests are performed by the Soil Labs. of the Departments of Agriculture of each Atlantic Province and provide information on the soil pH level, the organic matter content, the nutrient levels of the soil. Based on the soil fertility level determined, recommendations for fertilizer and lime applications are provided with the soil test results. Fertilizer recommendations are based on the nutritional requirements of vegetable crops to be grown and unless otherwise requested, are given in granular fertilizer requirements.



The soil pH level is a measure of the acidity of the soil. A soil pH of 7.0 is considered neutral; above 7.0, alkaline; and below 7.0, acidic. The soil pH affects the availability of soil nutrients with the majority of the essential nutrients being most available in slightly acidic conditions. While some vegetable are more tolerant of acidic soil conditions than others [Table 8], most crops grow best in a soil pH range of between 6.0-6.8.

Acidic soil conditions which can be identified by soil testing can be improved through applications of limestone. Two forms are available in Atlantic Canada; dolomitic, which contains both calcium and magnesium, and calcitic, which contains mainly calcium. Either form is effective for pH adjustment. The decision on which type to use can be based on the calcium and magnesium contents of the soil (from a soil test),

or by availability of product. The best time to apply lime is in the fall. This allows sufficient time for the material to break down and for pH adjustment to occur. Wood ash can also be used for pH adjustment. In general, ash has two thirds the adjustment value of limestone and therefore would be needed in a greater volume than limestone. It is however, available to any gardener that burns wood and can increase the potassium content of the garden soil. (See section on Potato Scab).

TABLE 8

RELATIVE TOLERANCE OF VEGETABLE CROPS TO SOIL ACIDITY

Slightly Tolerant (pH 6.0-6.8)	Moderately Tolerant (pH 5.5-6.8)	Very Tolerant (pH 5.0—6.8)
Asparagus	Bean	Endive
Beet	Bean,Lima	Fennel
Broccoli	Brussels Sprouts	Potato
Cabbage	Carrot	Rhubarb
Cauliflower	Corn	Sweet potato
Celery	Cucumber	Watermelon
Chard,Swiss	Eggplant	
Chinese cabbage	Garlic	
Leek	Kale	
Lettuce	Kohlrabi	
Muskmelon	Parsley	
New Zealand spinach	Pea	
Onion	Pepper	
Parsnip	Pumpkin	
Spinach	Radish	
	Rutabaga	
	Squash	
	Tomato	
	Turnip	

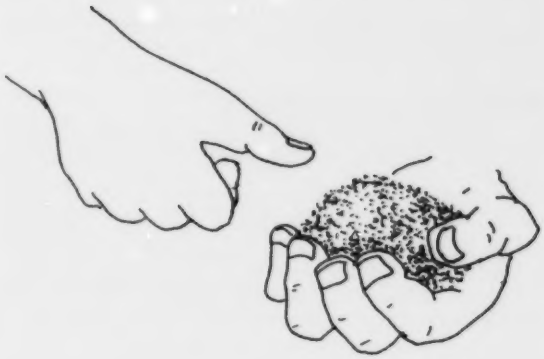
In addition to improved nutrient availability, pH adjustment decreases the availability of some soil elements such as aluminum and manganese which can be toxic to vegetable crops; promotes increased activity of soil micro-organisms for increased decomposition of organic matter and improved availability of organic nitrogen, sulfur, and phosphorus; improves the efficiency of granular fertilizers; and improves soil structure.

It is not necessary to have a yearly soil test. Through proper crop rotation and yearly additions of crop nutrient sources (either organic or inorganic) the soil nutrient level can be maintained and a test every 3 or 4 years is sufficient to monitor levels.

Spring Cultivation

The ground should be turned over in the spring as soon as it is dry enough to work. A good test is to mold a handful of soil into a ball. If the ball is not sticky and crumbles readily when pressed with the thumb, the soil is ready to work.

Working wet soil can destroy structure and cause compaction. The size of your garden and the tillage equipment available to you will determine the method of soil preparation used. A small garden or raised bed system can be easily worked with a spade or fork while large garden areas will require mechanical cultivation with a rototiller or tractor driven equipment.



There are three steps in spring cultivation. Primary cultivation, fertilizer application, and seed bed preparation. Primary cultivation consists of rough cultivation to incorporate plant residues, mulches or cover crops. The fertility source should then be applied and incorporated into the top 10 cm of soil with a rake or tillers. Fertilizer can be broadcast over the entire garden area or limited to actual row areas. Care should be taken when using commercial fertilizers or raw manures to avoid direct contact with the roots and top of young plants as burning can result. Following fertilizer incorporation, a final raking to remove stones, debris, and early germinating weeds will ensure a smooth, level seedbed for uniform germination and plant growth.

Row Establishment

Before planting, row type, row spacing, and crop location should be marked off with stakes and heavy twine. If wide rows or unsupported raised beds are the method of choice, now is the time to establish the beds and add extra organic matter and additional plant nutrients as needed. If single rows are the method of choice, establish row orientation and distance between rows and run twine between stakes to mark row locations. If vine crops such as pumpkins or squash are to grown, it is a good idea to set aside a separate location at one end of the garden, This reduces competition with other crops.

The distance between rows in the garden is determined by the crops to be produced and the type of weed control methods to be used. Rows too close together can cause competition between plants and with weeds for water, nutrients, and sunlight and make harvesting more difficult. Decreased air movement can also intensify disease pressures. Row spacings vary with the crops to be grown. Spacing requirements are listed in [Table 1]. Although it is most convenient to mark off the entire garden area at one time, not all crops can be planted at the same time. Early season, cold tolerant crops such as spinach, peas, onions, radish and lettuce can be seeded as soon as the soil can be worked. Tomatoes and other warm season

vegetables should not be planted until the danger of frost has past (Table 5). Therefore, to allow for ease of late season seedbed preparation, mark off the rows to be planted as required.

Seeding the Garden

Seeds can be planted by hand or with a seeder. Seed size varies and care should be taken to plant at the proper depth [Table 1]. Large seeds such as corn, beans, and peas can be planted 2.5 cm deep while small seeds such as carrots and lettuce should not be covered with more than .6 to 1.25 cm of soil. Depth of planting will vary with the time of year and soil conditions. Plant shallow in cool damp early spring soils to ensure emergence and deeper in late season or sandy soils to ensure adequate moisture for germination. After covering, tamp the soil lightly with the back of the hoe or rake to firm the soil and improve germination.

Seeds can be sown slightly thicker than recommended final plant spacing to allow for poor germination or seedling loss. Seeding too heavily however, wastes seeds, increases the potential of seedling loss through over crowding, and makes thinning more difficult and time consuming [Table 1].

Cool and Warm Season Vegetables

Vegetable crops can be separated into two categories, cool season frost hardy, or warm season frost tender [Table 4]. Cool season crops are able to withstand a few degrees of frost and can be planted as soon as the soil is ready. Warm season crops can not withstand frost and should not be planted out into the garden without protection until the danger of frost has passed. This date varies within the Atlantic province. See pages 9 and 10 to determine the average date of expected last frost for your region.

The growth period required between planting and harvest for each crop also varies. Crops such as radish,lettuce, spinach, beans, beets, carrots, turnips, and zucchini are ready to eat in less than 2 months while Brussels sprouts, tomatoes, sweet corn, peppers, eggplants, melons, onions, leek, squash, pumpkins, parsnips and potatoes require between 2-4 months. Therefore, due to the length of the growing season in Atlantic Canada, to successfully harvest warm season vegetables that require a long growing season, it is usually necessary to use transplants for such crops as pepper, tomatoes, eggplants, and melons.

Successive Planting

Some crops such as carrots and beets, are harvestable well before full maturity and are tasty for weeks or even months. Others, such as radish, spinach, broccoli, cauliflower, sweet corn and lettuce mature quickly and are past their prime within a matter of days. To maintain a constant supply of these vegetables, make a succession of plantings at regular intervals or plant varieties with early, mid, and late season maturity dates (most effective with sweet corn). Consistency of supply can be maintained in beans, cucumbers, and zucchini via harvest at regular intervals.

Storing Seeds for Next Year

Regardless of the best efforts in planning the garden and purchasing seed supplies, it is not unusual to have seeds remaining. This is not a problem as most seeds, properly stored, can be safely kept for more than one gardening season. To save seeds, seal the remaining seeds in the seed packet (mark the year of purchase) and place in a large jar or coffee can with an air tight lid. See Table 9 for storage life and required storage conditions.

TABLE 9

LIFE EXPECTANCY OF VEGETABLE SEEDS STORED UNDER FAVOURABLE CONDITIONS

Vegetable	Years	Vegetable	Years
Asparagus	3	Lettuce	4
Beans	3	Muskmelon	5
Beets	4	Onion	1
Carrots	3	Parsley	1
Celery/celeriac	3	Parsnip	1
Chard, Swiss	4	Pea	3
Chicory	4	Pepper	2
Cole crops	3-4	Radish	5
Corn	2	Rutabaga/Turnip	4
Cucumbers	5	Sorrel	4
Eggplant	4	Spinach	3
Endive	5	Squash/Pumpkin	4
Fennel	4	Tomato	4
Leek	2	Watermelon	4

To check seeds the following year for germination percentage, place a number of seeds (10-20) between layers of moist paper towel. Keep the towel moist, not wet, and count the number of seeds which germinate. Seeds with a low germination percentage (below 75%) can still be used but should be planted thicker than recommended spacing distance.

Soil Fertility

A porous, well drained, fertile soil is important for successful vegetable gardening. The availability of water and air is affected by the physical features of the soil. Fertility is greatly controlled by the overall soil condition. Both structure and fertility can be adjusted to improve crop growth.

Basically, there are sixteen chemical elements which are essential for crop growth. Three of these, carbon, hydrogen, and oxygen are obtained from the atmosphere and are readily available to plants as carbon dioxide and water. The remaining elements must be obtained from the soil. The major elements, nitrogen, phosphorus, and potassium are required in the greatest quantity for plant growth. The next most essential elements, secondary elements, are calcium, magnesium, and sulfur, and are required in smaller quantities. The remaining elements are required in varying amounts by different crops and in extremely small quantities and are therefore referred to as micro-nutrients. They include boron, manganese, molybdenum, chlorine, iron, copper, and zinc.

In general, most soils do contain a certain amount of each element. However, the actual total content of

each element in the soil is not necessarily available for crop uptake. To be available, each nutrient must be dissolved in the soil solution. This occurs through microbial decomposition, weathering of soil minerals, or via direct application of materials containing the necessary elements. Availability is also affected by the pH level of the soil with the majority of nutrients being most available at a pH range of 6.0 to 6.8.

As previously discussed, vegetable crops are either high, moderate, or light feeders [Table 6]. The level of major nutrients required by each group for productive growth per 100 square meters is approximately:

Heavy feeders: 8-15 kg nitrogen, 8 kg phosphorus, and 5-8 kg potash.

Moderate feeders: 5-12 kg nitrogen, 6-8 kg phosphorus, and 2-7 kg potash.

Light feeders: 3-5 kg nitrogen, 2-6 kg phosphorus, and 2-5 kg potash.

TABLE 10

BORON REQUIREMENTS OF VEGETABLES ARRANGED IN APPROXIMATE ORDER OR DECREASEING REQUIREMENTS

High requirement (more than 0.5 ppm in soil)	Medium requirement (0.1-0.5 ppm in soil)	Low requirement (less than 0.1 ppm)
Beet	Tomato	Corn
Turnip	Lettuce	Pea
Cabbage	Sweet potato	Lima Bean
Broccoli	Carrot	Potato
Cauliflower	Onion	
Asparagus		
Radish		
Brussels Sprouts		
Celery		
Rutabagas		

TABLE 11

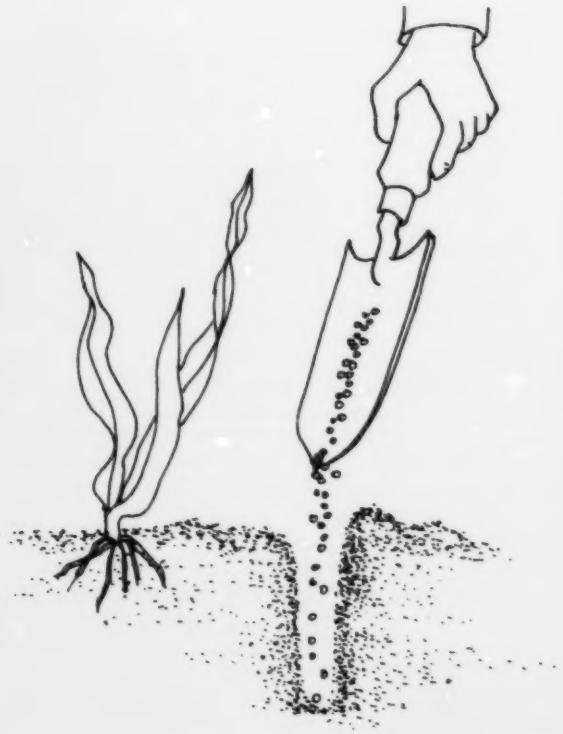
RELATIVE TOLERANCE OF VEGETABLES TO BORON ARRANGED IN ORDER OF INCREASED SENSITIVITY TO BORON

Tolerant	Semi-tolerant	Sensitive
Asparagus	Celery	Bean
Beet	Potato	
Broad beans	Tomato	
Onion	Radish	
Turnip	Corn	
Cabbage	Pumpkin	
Lettuce	Peppers	
Carrot	Sweet potato	

Secondary and micro-nutrients required will be present in the soil or will be provided by applications of such materials as limestone, gypsum, manures or composts. Of the micro-nutrient, boron is required by some crops in greater quantities than that which may be present in the soil and foliar applications of soluble boron (solubor or boric acid) may be necessary (see Common Disorders; Brown Heart of rutabagas). However, other crops are sensitive to high boron levels and would not require additional applications. See Tables 10 and 11 for tolerance and sensitivity levels.

Granular fertilizers

There are many sources of nutrients for plant growth. The type used will depend on personal preference and availability of materials. Granular fertilizers containing specified amounts of nitrogen, phosphorus, and potassium are readily available and easily applied. Commonly used garden fertilizers of this form are 12-24-24, 10-10-10, or 17-17-17. The numbers given represent the percentage of nitrogen, phosphorus, and potassium contained in the fertilizer formulation. For example, 12-24-24 contains 12% nitrogen, 24% phosphorus (P2O5), and 24% potassium (K2O). The nutrients are present in the fertilizer in a soluble form that, upon application to the soil, dissolve into the soil solution and are readily available for plant uptake.



Granular fertilizers can be broadcast in the spring prior to planting and incorporated into the soil or banded 7-10 cm below and to the side of the row area after seedling emergence. The choice of fertilizer and rate of application are determined from the results of a soil test. In the absence of a soil test, the following application rates will provide sufficient nutrients for crop growth. For heavy feeders, 8 to 15 kg of 17-17-17 or 8 to 12 kg of 12-24-24 per 100 square meters. For moderate feeders, 5 to 10 kg of 17-17-17 or 6 to 8 kg of 12-24-24 per 100 square meters. For light feeders, 3 to 8 kg of 17-17-17 or 3 to 5.5 kg of 12-24-24 per 100 square meters.

Care should be taken to avoid direct contact with the root zone of the plants as granular fertilizers can cause burning of the tender root tissue. Also, due to

the soluble nature of granular fertilizers, heavy spring rains can cause some loss of the nutrients (mainly nitrogen) through leaching.

Fertilizers from Natural Sources

Nutrients can also be obtained from natural sources such as organic materials and rock powders. This includes farm manures, green manures, composts, seaweeds, crop residues, wood ash ,etc. and products such as rock phosphate, bone meal, and sul-po-mag. These materials are often used in combination with granular fertilizer to provide organic matter to the soil but, through careful management,can be used as the sole source of plant nutrients in the garden.

Natural fertilizers supply nitrogen, phosphorus, and potassium for crop growth. In many cases, they also supply secondary and micro-nutrients to the soil.They differ, however, in the level of nutrients and in the availability. Natural sources contain nutrients which must be broken down by microbial action to a form which is available for crop uptake. Therefore, to be most effective, application should be made well ahead of expected planting date.

Rock powders such as rock phosphate should be applied in fall or incorporated into compost for decomposition and nutrient availability. Sul-po-mag which contains sulfur, potassium, and magnesium can be applied in early spring. Lime which is normally applied to soil for pH adjustment is most effective if applied in the fall. Lime supplies calcium, and if dolomitic, magnesium as well. Gypsum is a source of calcium and sulfur. It has little or no effect on soil pH but has the same effect on soil structure as limestone. Gypsum is beneficial source of calcium for such crops as potatoes which require a more acidic soil condition for the control of common scab. It should however, be applied in spring as the calcium in gypsum is more available than in limestone and would have a greater tendency to be leached down into the soil by rains.

Wood ash, which contains potassium can be applied in the spring. Care should be taken to avoid overuse of wood ash as it has two thirds the neutralizing effect of lime and if used in excess can create alkaline soil conditions. Ash can also cause burning of tender plant tissue. Other materials often used by organic gardeners include dried fishmeal, bonemeal, soybean meal, commercially available composted animal manures, and liquid fish or seaweed extracts.

Organic materials such as raw or partially broken down manures, leaves, grass clippings, eel grass and seaweed should be applied the previous fall and incorporated into the topsoil or composted and applied in the spring before planting. Green manures should be tilled in the previous fall or if planted as a cover crop, early in the spring with a good coating of well rotted manure or compost to encourage decomposition. Composts, in the finished form are a ready source of slow release plant nutrients and can therefore be applied shortly before planting or as a top dressing during the growing season.

One draw back of natural fertility sources is the low nutrient content of most natural materials. Because of this, greater quantities of these fertility sources are necessary to provide comparable rates of required N,P, and K. The variability of nutrient content of some products can also be a disadvantage. This is most true for organic materials. Average nutrient content levels are listed in Table 12 and can be used as guidelines for application.

TABLE 12
PRIMARY NUTRIENTS CONTAINED IN ORGANIC FERTILIZER MATERIALS READILY AVAILABLE IN ATLANTIC REGION

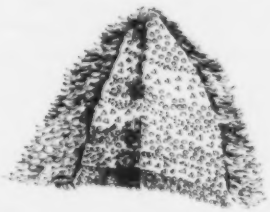
	Nitrogen (% N)	Phosphorus (% P2O5)	Potassium (% K2O)	Relative Availability
ORGANIC MATERIALS:				
Manures (fresh)				
Cattle	.55	.15	.45	medium
Hog	.50	.35	.45	medium
Horse	.65	.25	.50	medium
Poultry	1.00	.85	.45	medium-rapid
Rabbit	2.40	1.40	.60	medium
Sheep	1.05	.40	1.00	slow-medium
Garden Compost (not fortified)	1.5-3.5	0.5-1.0	1.0-2.0	slow
Bonemeal	0.7-4.0	18-34	0	slow
Sawdust	4	2	4	very slow
Kelp	.9	.5	4-13	slow
Fishmeal	10	6.0	0.0	medium
Soybean	7.0	1.2	1.5	medium
ROCK POWDERS & ASHES:				
Phosphate rock	0	30	1-2	very slow
Sul-Po-Mag	0	0	22	medium
Wood ashes	0	2.0	6.0	rapid

Compost

Compost is relatively easy to make and is an excellent source of organic matter and plant nutrients required for growth by vegetable crops. In general, almost any organic material available can be incorporated into the compost pile. This includes grass clippings, kitchen wastes (coffee grounds, vegetable peelings, etc.), weeds and vegetable residues from the

garden, leaves, manures, hay and straw, and seaweeds such as kelps and rockweed. Things to avoid include bones and meat as they decompose slowly and may attract rodents, diseased vegetative matter as the disease organisms may not die during decomposition, and grass clippings from herbicide treated lawns. A compost pile can be free standing or contained in bins which have side and bottom openings to provide air circulation. A free standing pile should initially be approximately 1.5 meters wide and 1.0-1.5 meters high to ensure initial temperature build-up. The length of the pile is not critical.

The initial material mix should have a carbon to nitrogen ratio of 25-30: 1. This is achieved by combining materials from different sources. Carbon sources include hay and straw, sawdust and wood chips cornstalks, peat moss, and leaves while nitrogen sources include vegetable wastes, leaf clippings, and animal manures. Avoid the addition of lime or wood ash to the compost pile as alkaline conditions within the pile could result in the loss of nitrogen. A rule of thumb to remember is that the smaller the particle, the quicker it will break down. Therefore, large items such as corn stalks or woody cabbage stems should be chopped or shredded before incorporation. Particle size and structural strength are important to prevent compaction and loss of air space within the pile. For example, a pile composed mostly of grass clippings, fine sawdust, wet garbage, or leaves will have a greater tendency to compact than a pile composed mainly of coarse textured straw or shavings. See Table 13 for information regarding material C: N ratio, structural strength, and degradability.



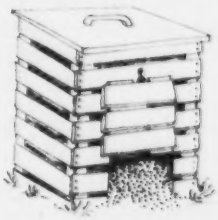


TABLE 13

RAW MATERIALS FOR COMPOST PILE CONSTRUCTION

Origin of Materials	C/N Ratio Nutrients	Structural Stability	Degradability
Domestic:			
Kitchen wastes	12-20	poor/medium	good
Coffee grounds	20	poor/medium	medium
Gardening & Landscaping:			
Wood chips	100-150	good	poor
Sawdust			
(beech)	100	good	poor
(fir)	230	good	poor
(old)	500	good	poor
Garden waste	20-60	good	medium
Foliage	30-60	medium/good	good
Grass clippings	12-25	poor	good
Vegetable wastes	13	poor	good
Agricultural:			
Poultry manure (fresh)	10	poor	good
Poultry manure (with litter)	13-18	medium	medium
Cattle manure	20	medium	good
Hog manure	5-7	poor	good
Horse manure	25	good	good
Manure & straw	25-30	good	good
Straw:			
oat/rye	60	good	medium
wheat	100	good	medium
barley	40-50	good	good
Residues of mushroom culture	40	good	medium/good

Oxygen availability, moisture content, and temperature are also important factors for successful composting and in many ways are dependent upon each other. The breakdown of materials in the compost pile is carried out by micro-organisms which require oxygen to function. This oxygen is present in the space between the different particles in the pile (pore space). While the blend of materials should be moist to the touch, free-running water within the pile will fill the pore spaces resulting in the unavailability of oxygen (anaerobic conditions) to the micro-organisms. The heat (temperature) of the pile comes from the activity of the micro-organisms. If the micro-organisms cannot function, there will be no heat or decomposition occurring.

Begin the pile with a 15-20 cm layer of vegetable matter. Follow with a 7.5-15 cm layer of manure and then a 1-2 cm layer of soil. Repeat layers until pile is 1-1.5 meters high. A small layer of finished compost can also be added with or in place of the soil to

encourage the start-up of the decomposition process. Also, to speed the decomposition process, although not really necessary, a handful of high nitrogen fertilizer can be added to each layer. If materials are not moist, sprinkle layers lightly with water. The proper moisture content is 50-60%. (If a few drops of water can be squeezed from a handful of mixed materials, the moisture content is right).

As decomposition begins, the microbial activity will be high and the temperature of the pile will begin to increase. For the rapid breakdown of materials and to ensure the destruction of disease organisms and weed seeds, a temperature of between 48-60°C. should be obtained and maintained for a 10 to 14 day period. The temperature of the pile will begin to drop as the micro-organisms use up the available oxygen within the pile and slow down in their activity. When the temperature drops below 40°C., it is time to turn the pile. In addition to replenishing the oxygen supply to the micro-organisms, turning the pile reblends the materials which make up the pile which is important for the following reason. The initial temperature increase, level of microbial activity, and decomposition of materials will be greatest in the interior core of the pile. Turning the pile will blend the outer, less composted portion of the pile with the more composted interior materials to ensure a more evenly broken down final product.

If the temperature does not go up initially or the pile cools down quickly, one of four things can be the problem: insufficient nitrogen, excess moisture, compaction of materials or lack of moisture. If nitrogen is a problem, add additional manure or high nitrogen inorganic fertilizer. Excess moisture and compaction will cause an anaerobic (without oxygen) condition in the compost pile. This results in very slow composting and is usually accompanied by an unpleasant odor. To eliminate these conditions, turn the pile and/or add more dry or bulky materials to the pile. If insufficient moisture is a problem, turn the pile and add more water. If the temperature of the pile increases above 60°C., add more water or attempt to compress (pack down) the pile to reduce the available oxygen within the pile.

Often, composting is avoided as being too much work, due to the perception that it must be turned every week. This is not necessarily true. If everything is proper during pile construction, it is doubtful that with a free standing pile, any more than 2 or 3 turnings will be required to have finished compost that is dark and crumbly, odorless and easy to apply. Compost, made in a bin, will probably need only 1 or 2 turnings.

Transplants

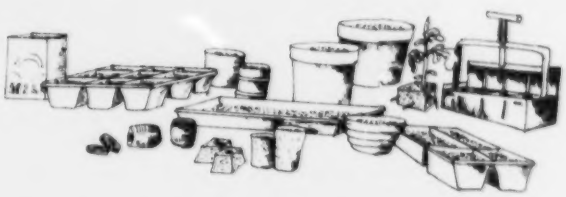
Transplants can be grown at home or purchased from garden centers or greenhouse operations. Home transplant production is fun and for the serious gardener, is a great way to start off the gardening season. It is usually necessary for early season vegetable production or for the production of crops, or crop varieties, not usually available from local suppliers. By starting transplants at home, the home gardener can produce the varieties he or she has found to perform well in their garden or test new varieties which are not yet available from local suppliers.

Care must be taken to provide the growth conditions required for healthy, disease free plants. Most vegetable transplants require 12-14 hours of sunlight and temperatures of 20-24°C. As this is difficult to obtain under normal household conditions, the use of a greenhouse or fluorescent lighting is necessary. Special horticultural fluorescent lights are available from garden supply centers, or a combination of standard cool white and daylight fluorescent lights will provide adequate lighting. Insufficient lighting will result in spindly growth.

Growing Media

The growing media should be fertile, provide good drainage, have good water holding capacity, and be free of herbicide residue, weed seeds, and disease and insect problems. As this is difficult to obtain with home mixes containing garden soil, the use of a purchased sterilized growing media is advisable. While growing medias are available ready to use, home mixtures can be made using equal amounts or peat moss and vermiculite or perlite. Compost can be used in the growing media but only if it is broken down to a fine black crumbly state and has heated sufficiently during decomposition to destroy disease organisms and weed seeds. If garden soil is used in the mix, sterilize the soil in the oven before blending into the mix. To sterilize, place shallow layers of soil in metal containers in the oven for one hour at a temperature of 82°C.

Plant nutrients should also be added either directly to the growing media or supplemented to the growing transplants on a regular basis. The type of fertility source applied will depend on the production system. Conventional home gardeners can add superphosphate, limestone and ammonium nitrate to the media or apply water soluble starter fertilizers on a weekly basis. Organic gardeners can supply adequate nutrients with weekly applications of compost tea. Composts used to make compost tea must be well broken down and have heated sufficiently during decomposition to destroy disease organisms. For any transplant requiring more than 3 weeks of growth period, supplementary fertilization is usually required even if there has been fertilizer added to the initial mix. Again, water soluble fertilizers or compost teas may be used for this purpose and should be applied on a weekly basis.



The selection of containers for transplant production is somewhat dependent on the crops to grown. Some crops are sensitive to transplant shock [Table

14] and should be started in individual pots or cellular trays from which they can be removed gently at transplanting without disturbing the root system. Another option to individual containers is the use of 'Jiffy pellets', 'soil blocks' or peat pots which are placed directly into the soil with the plant. While less sensitive crops can be started in trays or flats and separated at planting, 'modular' or 'cellular' trays allow for individual plant root development. Individual root development reduces transplant shock which results in quick root establishment after transplanting. Many recyclable products around the home such as paper cups, milk cartons, aluminum trays, or tin cans can also be used to start transplants. Be sure to make drainage holes in the base of recycled containers. When reusing containers that have previously held transplants, wash in warm, soapy water and sterilize in a solution of 1 part 6% bleach to 9 parts hot water.

TABLE 14

TRANSPLANT GROWTH REQUIREMENTS

Crop	Growth Period (weeks)	Germination Temperature Optimum °C	Minimum °C	Growing Container Open Flats	Cells*
Broccoli	4– 6	27	5	•	•
B. Sprouts	4– 6	27	5	•	•
Cabbage	4– 6	27	5	•	•
Cauliflower	4– 6	27	5	•	•
Celery	8–10	21	15	•	•
Cucumber	2– 3	35	16		•
Eggplants	9–10	27	16	•	•
Lettuce	8– 9	20	5	•	•
Melons	3– 4	32	15		•
Onion & Leek	9–10	35	5	•	•
Peppers	8–10	35	15	•	•
Pumpkins	3– 4	32	15		•
Squash	3– 4	32	15		•
Tomatoes	6– 8	35	10	•	•

*Cells are: peat pots, peat pellets, cellular trays or pots.

Seeding and Germination

To seed, follow direction on the seed packet. Prepare media by adding water until it is moist but not water logged. Place into planting containers and prepare a level surface for uniform germination. Most seeds will germinate if sown at a depth of 0.5 cm For crops planted in trays, sow at a seeding density of 8 to 10 seeds per 2.5 cm When seedlings are 2 to 3 cm tall, thin to proper spacing or transfer to individual containers . To seed cucurbits, plant 2-3 seeds per container and thin to 1 or 2 per container after emergence.

After seeding, place containers in a plastic bag or cover with plastic sheeting or a plate of glass to retain soil moisture. Do not place containers under artificial lighting until after emergence. After germination, remove covering and place into well lit conditions. If using artificial lighting, place lights 10 cm above seedlings. As the seedlings grow, maintain a distance of 12 to 15 cm between seedlings and light.

The germination temperature and growth period required from seeding to transplant time varies with the crop. As plant hardiness also affects when a crop should be planted out into the garden, these factors should be considered and a transplant seeding schedule prepared to ensure vigorous transplants for the garden. While regular fertilization and proper lighting will help, transplants started too soon may become weak and spindly before it is time to plant out. See Table 4 and 14 for schedule preparation.

Moisture Requirements

Water transplants on a regular basis. Always use water which is at room temperature. Never let the soil dry out completely but don't keep soil water logged. Soil that crumbles readily is at the right soil moisture. Excess watering should be avoided to reduce the incidence of damping-off, the most common transplant disease problem. It is caused by soil borne pathogens and can be avoided through the following preventative measures:

- use a sterilized growing media.
- use sterilized tools and containers or new containers.
- use resistant varieties.
- avoid excessive watering.
- practice good sanitation around the growing area by removing plant debris.
- avoid the introduction of organisms on diseased tissue.
- keep the temperature of the soil mix above 10°C. Damping off is more prevalent in cold soils.

Hardening Off and Planting

Most transplants should be hardened off before they are placed in the garden. Begin about two weeks before transplant time by placing the plants outside in a sheltered sunny location during the daytime. As the transplanting date approaches, leave the plants out over night (for the last 3-4 nights). For vine crops such as muskmelons, cucumbers and watermelons, wait until after the danger of frost and cold weather has passed before placing out of doors. Only 2-3 days of hardening off are required at this time. The best time to transplant is in overcast weather or in the evening. Water plants well before setting them out. Dig a hole big enough for the root ball and set plants in the ground to the level of the lowest leaf. A slight depression can be left to act as a water reservoir. Be sure to bury peat pots entirely, as the peat will act as a wick to draw water away from the root zone. A starter solution should be applied at transplanting. The type applied will again depend on the method of production. Water 2 to 3 times during the first two weeks after transplanting to prevent drying out and to allow time for root establishment. Some protection from the wind may be required for tender transplants.

Water

Water is essential for plant growth. For uniform growth, vegetable crops require 2.5 cm of moisture per week. For a proper soaking, this amount should be received at one time rather than in small quantities (a soaking rain instead of showers). Light quantities will only encourage shallow rooting of crops and therefore increase the need to water. Insufficient moisture can result in the reduced availability of plant nutrients, mis-shapened fruit due to uneven growth conditions, and increased incidence of physiological disorders such as blossom end rot of tomatoes or blackheart of celery.

If adequate moisture is not received naturally, supplementary water should be provided. This can be accomplished with a bucket, a hose, or with irrigation equipment such as sprinklers, soaker hoses or trickle irrigation. While the first two methods are time consuming, their usage may be necessary when location is a factor. Irrigation equipment can be turned on and left. To know how long to leave the irrigation running, place a few containers under the irrigation line(s). The time required to accumulate 2.5 cm of water in the containers is the length of time to let the irrigation run.

If possible, water in the morning when using overhead watering systems (sprinklers, watering cans, etc.). Wet foliage is more susceptible to disease development. Soaker hose or trickle irrigation systems can be used in either morning or evening. Mid-day watering is not advisable with any of the previously discussed methods. More frequent watering may be required on sandy or shallow soils than on deep or heavy clay soils.

Weed Control

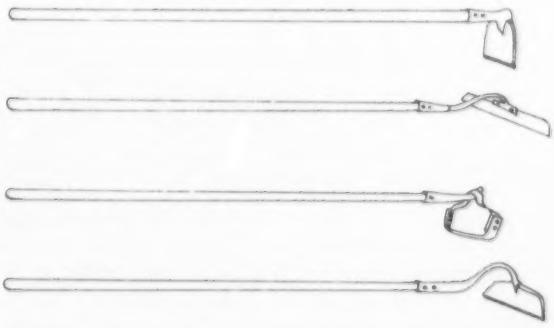
Weeds can be one of the greatest aggravations to gardeners. They compete with the garden crops for moisture, nutrients and space and can provide hiding places or act as host plants for insect pests or disease organisms. If left and allowed to get out of hand they can, in the spring, reduce germination, and, in the summer, reduce air circulation, creating favorable conditions for diseases. On the other hand, some weeds are beneficial in that they act as a host for beneficial insects, as a trap crop for some insect pests, and as indicators of soil condition.

Weeds can be controlled through cultivation either by hand or with a rototiller, mulches, cover crops, summer fallow or a combination of these methods. Of the methods, cultivation and mulches can be incorporated into the growing garden while cover cropping and summer fallow for weed control cannot.

Cover cropping and summer fallow are techniques to use if weed populations are high or in the establishment of a new garden site. Cover crops such as buckwheat or rye are planted and grown until they begin to flower. They grow quickly and smother out any weed competition. At flowering, they are mowed and worked back into the soil. If cover crops are grown early in the season, vegetables can still be grown or a second cover crop can be seeded. To summer fallow, keep the soil bare throughout the growing season. Work the soil every 10 to 14 days or as required by weed growth. As summer fallowing is hard on soil structure, it is not normally recommended. However when establishing a garden from a sod or uncultivated, weedy area, a year of summer fallow may be necessary.

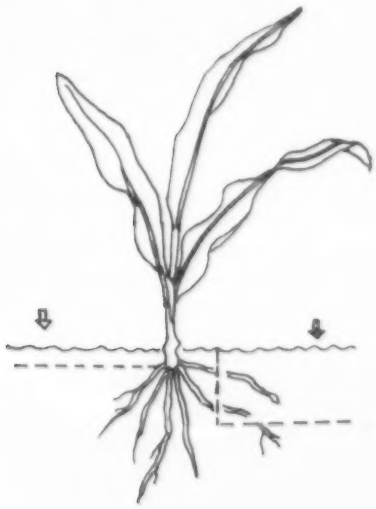
Mechanical Weed Control

Some degree of weed control can be achieved before planting by cultivating the soil every 10-14 days to destroy weed seedlings as they appear. Begin as soon as the soil is ready to work and continue until planting. This is most easily carried out with a rototiller or tractor driven cultivation equipment.



After planting, cultivate the row areas frequently with hand held equipment to remove weed seedling as soon as they appear. Small weeds are easily removed with shallow cultivation and are less injurious to crop roots. Deep cultivation required for removal of large weeds can disturb or destroy the fine feeder roots of the crops. Also, some difficult weeds such as couch grass, wild mint, and purslane, are more easily controlled when they are young. The best types of equipment for this job include an assortment of hoes such as straight, Dutch, stirrup, wiggle, and wheel, or the various assortments of finger weeders. The type of hoe used will depend upon personal preference as well garden size or row type. For example, wheel hoes are excellent tools for between row cultivation

and are much easier on the operator. For large garden sites, between row cultivation after planting, can be carried out with rototillers. Weed control is normally most difficult during the establishment phase of a garden area. After a few years of gardening, and persistent cultivation, the majority of weed problems can be brought under control.



Chemical Weed Control

Chemical weed control is not a recommended practice in the established home garden. Although many products are available for weed control in vegetable crops, most are specific to only a few crops and can cause damage if applied to non-recommended crops. In addition, very few are registered for home garden usage and therefore should not be applied.

For control of perennial weeds in the establishment of a new garden site, in the year prior to planting, the herbicide gylphosate can be applied. Allow the weeds to emerge and apply glyphosate to the foliage. Allow at least 10-14 days for the herbicide to be effective. Follow the direction on the label and wear protective clothing.

Care should be taken in the application of lawn weed herbicides in the garden vicinity as drift of the herbicide can cause stunting or deformity of crops. Spray lawns on a calm day. Also, if the same sprayer is used for both lawn herbicide and garden insecticide or fungicide application, be sure to thoroughly clean the sprayer with soap and water (three repetitions) to remove any potentially damaging residue. Remember to wash hoses and nozzles. The best option is to have a separate sprayer for herbicide application.

Organic Mulches

The use of organic materials for mulching of crops is advantageous as a weed control method, in conserving soil moisture and as a good source of additional soil organic matter. Organic materials however cool the soil and therefore should not be applied until after crops have germinated. The soil should be lightly cultivated before application.

Apply mulches between rows to a depth of 8-10 cm Mulch applied close to the plant should not be as deep. Deep layers of organic materials make an excellent hiding place for slugs.

The best type of organic mulching materials to use are those that are locally available. Excellent materials include compost, well rotted or composted manure, straw or hay, eel grass seaweed, old sawdust, wood chips, grass clippings, newspapers, or leaves. When using mulching materials such as straw, sawdust, wood chips, or even leaves, a layer of compost, well rotted manure, or a sprinkle of high nitrogen fertilizer should be applied to the soil surface before the mulch. This will reduce the possibility of nitrogen deficiency caused by mulch decomposition. When collecting seaweed or eel grass to used for mulching, select material which has been on the shore for a long period of time and is above the high tide line. Another option is to collect the material in the fall and place in small piles for the winter months. This removes the salt and reduces the chance of salt burn to the plants.

Organic mulching materials can be removed in the fall or incorporated into the soil to improve the organic matter content. Incorporation should be carried out in the fall and is most effective if the materials have broken down well prior to incorporation or if the soil is healthy, high in organic matter, and abundant in soil micro-organisms. Materials should be incorporated into the top 8-10 cm of soil to encourage breakdown. Be sure to leave a rough surface to reduce erosion.

Season Extension

Season extension is the practice of lengthening the growing season by creating a warmer microenvironment for specific plants using a number of techniques. The use of season extension techniques is most effective for transplanted warm season crop such as tomatoes, peppers, eggplants, cucumbers, squashes, muskmelons, and watermelons. However it can also be used at the start of the season to bring on an early crop of salad greens.

Plastic Mulching

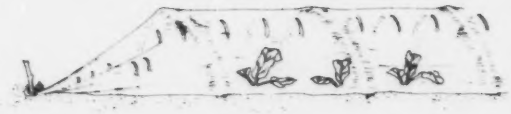
Black or clear plastic mulch applied to the soil before planting helps to conserve moisture, increase soil temperature, increase crop yields, and in the case of black plastic, aid in weed control. Clear plastic mulch does not control weed growth. The mulch material, be it purchased agricultural mulches or black garbage bags, should be applied to the soil surface before planting and secured by burying the edges with soil. To transplant, cut holes with a sharp knife, razor blade, or bulb planter and plant through the hole. Photo degradable mulches are available for the home garden. Over the summer months, the material is broken down into tiny pieces by the ultra-violet radiation of the sun. The buried edges or portions of the mulch covered by crop foliage, however, will not

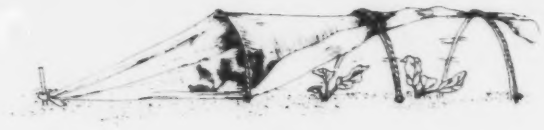
break down. Any type of plastic mulching material should be removed from the garden site at fall clean-up.

Row Covers

To encourage growth even further, the use of individual cloches, supported row tunnels (that look like mini greenhouses), or unsupported fabric row covers can be applied over the row after planting.

- Cloches are individual protective covers that are placed over the plant at planting time. Many products around the home can be used as cloches such as large plastic jugs (ie. vinegar bottles) or large clear plastic bags. Ventilation is required to prevent extremely high temperatures which can result in tissue burn or even plant death. This can be achieved by either cutting holes or slits in the cloche (as the temperature increases) or by removing the cover during the day. Several types of cloches are available commercially. For some such as 'Hotkaps' a small split must be made in the material after it is placed over the crop. As the plant increases in size, the slit is increased and the plant grows through. Other types of commercially available cloches are open on the top or are perforated to provide the required ventilation.
- Row tunnels and unsupported row covers are applied over the entire row area after planting. While unsupported row covers can be used over direct seeded crops, both methods are more effective when used in conjunction with black plastic mulching on transplanted crops. They are usually pre-ventilated and are left in place until the crop runs out of growth space. It is best to remove row cover materials on a calm, cloudy day as crops may be slightly more tender than those produced without cover. The advantages of using row cover's include earlier set out date, earlier maturity, and increased yields. Crops protected by row covers can be planted 7-10 days ahead of the recommended set out date as some frost protection is provided.





To construct supported row tunnels, use 9 gauge galvanized wire cut into 1.9 meter lengths. Place the wires 1.5 meters apart over the row. Construction grade polyethylene (1.5-1.75 meters wide, 1mm. weight), is placed over the wire and secured on either side by burying the edges in soil. As the temperature increases, holes or slits are cut in the plastic to provide ventilation to the crop. An alternative method of tunnel construction is illustrated. To ventilate this type of tunnel, the plastic on one side of the tunnel is lifted and is held in place by the twine. If cool night temperatures are expected, the plastic is lowered.

- Unsupported row covers are commercially available products. They are fabric-like, polyester or polypropylene materials which are light weight, light transmissive, and are self ventilated. They are placed over the crop and the edges are secured by soil. They can be used on either transplanted or direct seeded crops and with or without mulch. Fabric row covers can also be used for insect control in cole crops and carrots to protect against root maggot flies, and in cole crops against caterpillar insect pests.

- Beans and sweet corn respond to another method of season extension known as the solar trench. In this method, crops are direct seeded in the base of a trench 12-15 cm deep. The trench is covered with clear plastic secured at the edges with soil. This creates a micro-climate for crop growth. The crop can be left under until it is pushing against

the plastic. Ventilation of the plastic is important to prevent crop damage through burning. To ventilate, cut hole or slits in the plastic at regular intervals as crop growth and outside temperatures require. This method of season extension also permits planting 7-10 days ahead of recommended planting date and provides an earlier harvest. Weeds however, can be a problem with this method of production as they benefit from the favorable growing conditions as well as the crop. The early start and maturity are again the biggest advantage of this method.

In a well established garden, permanent cold frames are a useful technique for season extension. These structures are inexpensive and can usually be made from scrap lumber using old storm windows and/or clear plastic film as a cover. More elaborate structures can be insulated and double glazed to serve as mini-greenhouses.

Companion Planting

There are as many definitions and theories on companion planting as there are books written on the topic. To many the concept of companion planting is the planting of a specific type of flower or herb close to an equally specific vegetable crop to repel insect pests or to enhance the growth of the crop. This is not necessarily the case.

"Companion" plants can be used to repel insect pests, but, in a more broader sense of the word, companion plants can also be defined as plants with contrasting properties which compliment each other. Under this definition, there are many types of companion planting which can be used by any gardener. They include: sun loving and shade loving crops; heavy feeders and light feeders; shallow rooted with deep rooted crops; slow growing with fast growing crops; crops such as peas and beans which incorporate nitrogen into the soil to assist other crops (and themselves); and crops which attract beneficial insects or act as a trap crop for insect pests.

It is difficult to give specific recommendations for companion planting. Some repellent crops work due to their aromatic nature (for example, dill and mint can repel white cabbage moth from cabbage and broccoli). The repellent ability of other crops is not fully understood. (ie. beans interplanted with potatoes will reduce Colorado potato beetle and leafhopper damage). Also, the exact ratio of repellent plants to crop plants is difficult to determine and can vary from garden to garden. For the best results, consult some of the many books on the topic and conduct your own experiments to determine the best combination for your garden.

Pest Management for Problem Prevention

All vegetable crops have insect and disease organisms which can create problems for the home gardener. To garden and not expect pest problems is unrealistic. However for enthusiastic home gardeners, insects and diseases are not problems but rather part of the challenge of gardening. Preventative medicine is best and includes tricks of timing and cultivation.

Begin with a good rotation. Move crops around in the garden from year to year to prevent the build-up of disease organisms and overwintering insect pests. Try not to plant the same crop or crop family [Table 3] in the same place in the garden any more than once every three years.

Here are a few general principles to observe when planting:

- Avoid side by side planting of crops which are susceptible to the same pest problems.
- Interplant non-related crops to reduce pressures or use companion planting to help repel insect pests.
- Don't overcrowd. Use the proper row and plant spacings to reduce competition for moisture and nutrients and to increase air circulation for disease control.
- Use disease free seeds and healthy transplants.
- Delay planting to avoid early generations of some insect pests. This is effective in carrots and cole crops to avoid the early generation of root maggots.
- Delay planting of crops sensitive to cool, wet soil conditions in order to avoid problems with poor germination, damping-off, seed or root rot, or early season insect problems. (cutworms and seed corn maggots)
- Use resistant or tolerant crop varieties which are most suited to the climatic conditions of the region. Disease resistance and tolerance is specific. Consult the seed catalogues when ordering and select according to your needs.

Proper soil conditions are also important for a preventative approach. A healthy, fertile, well drained soil with good aeration permits rapid germination, root penetration, and strong plant growth. Strong, healthy plants are better able to resist pest problems than plants weakened by stress.

Monitor soil fertility every two to three years with a soil test. Make yearly applications of plant nutrients as required for plant growth. Adjust the soil pH as required. Maintain a high level of organic matter in the soil.

Keep an eye on moisture levels throughout the growing season. An even soil moisture content will encourage consistent growth and reduce plant stress. Water properly to reduce disease development. Keep out of the garden when foliage is wet to avoid spreading disease organisms.

Control weeds in the garden to reduce competition for moisture and nutrients and to improve air circulation.

Practice good garden sanitation throughout the gardening season and during fall clean-up. Remove diseased tissue from plants as it appears. Removal of plant debris will also eliminate hiding places for bothersome insects such as slugs and earwigs. To prevent overwintering of pests and diseases remove infected crop residues in the fall. Non-infected crop residues can be incorporated into the soil.

Prevention, however, does not eliminate every pest. There are a number of insect and disease organisms,

common to the Atlantic region which, despite all efforts, cause yearly damage to vegetable crops. Specific control methods may need to be employed from time to time. A number of pesticides are available to the home gardener to control insect and fungus problems in the home garden. The most commonly available products are listed in Tables 15 and 16. Some of these products are poisonous not only to insects but also to bees, other beneficial insects, mammals and/or fish. Special precaution should be taken during their use.

TABLE 15

INSECT AND INSECTICIDE CONTROL TABLE

	Bacillus Thuringensis	Carbaryl	Chlorpyrifos	Diazinon	Dimethoate	Soap	Malathion	Methaldehyde	Methoxychlor	Rotenone	Diatomaceous Earth	Permethrin	Pyrethrin
Aphids		X		X	X	X	X			X			X
Asparagus Beetle		X					X		X	X			X
Cabbage Looper	X	X		X			X		X	X		X	X
Colorado Potato Beetle		X		X	X		X		X	X			X
Corn Earworm		X										X	X
Cucumber Beetle		X		X			X		X	X			X
Cutworms		X	X	X									
Diamond Back Moth	X	X		X					X	X		X	X
Earwigs		X	X			X					X		
European Corn Borer		X		X						X		X	
Fall Armyworm		X		X								X	X
Flea Beetle		X	X	X					X	X			X
Imported Cabbageworm	X	X		X			X		X	X		X	X
Leaf Miner					X		X						
Onion Thrips		X		X			X			X			
Potato Stem Borer		X		X								X	
Purple Back Cabbageworm	X	X		X					X	X		X	X
Root Maggots			X	X									
Seed Corn Maggot			X	X									
Slugs								X			X		
Spider Mites				X	X	X	X						
White Grubs													
Wireworms				X									

TABLE 16
DISEASE AND FUNGICIDE CONTROL TABLE

	Benomyl	Captan	Chlorothalonil	Copper	Maneb	Oxine benzoate	Zineb
Anthracnose		X	X	X			
Clubroot							
Damping-off		X				X	
Downy mildew		X	X	X	X		
Early blight		X	X	X	X		X
Gray mold		X					
Late blight		X	X	X	X		X
Powdery mildew	X		X				
Scab							
White mold							

Not all insects found in the garden are harmful. The garden can be considered a 'mini environment' alive with growing plants and many species of living organisms. In addition to pest organisms, the garden is also alive with beneficial insects such as pollinators important for crop production, decomposers important for nutrient availability, and predators and parasites which aid in insect control. Most home garden chemicals are non-specific and destroy the beneficial with the pest insects. Because of this, knowledge of both the harmful and the beneficial organisms are important for effective control.

To be most effective with control methods, it is a good idea to be able to:

- visually identify the pest organism as well as the beneficial.
- know the type of damage caused.
- know the plants most frequently affected by each pest problem.
- know the portion of the plant affected (where to look).
- know the time of year to expect the pest organism.
- know the method(s) of control available to use; both cultural and chemical.
- know if control is really necessary.

This sounds confusing and time consuming but it doesn't have to be. During regular trips to the garden for maintenance or harvest purposes, take a few minutes to walk around and look for possible problems such as wilted leaves or plants, holes in leaves, discoloration of plant tissue or the actual insect. Frequent monitoring for pests will catch the damage as soon as it begins. A decision can then be made regarding control application, depending upon the level of damage occurring. Although at first glance, an insect population or a problem may appear serious, some types of damage do not seriously affect the growth of the plant, the edible portion of the plant or the overall yield of the crop. Also, most home gardeners can accept some level of insect damage as affected areas can be removed easily during food preparation. When making a pest control decision, always remember the beneficial insects. Much of the information needed to make a decision is contained in this guide or in the references listed in the Appendix. Help is also available from the local department of agriculture.

Cultural Control

There are a number of cultural control methods which help to protect garden plants:

- Place cardboard collars or tin cans (with both ends cut out) around transplants to prevent cutworm damage. Crushed egg shells or seashells placed around plants or around the garden perimeter will help to deter slugs.
- Hand pick the larger, slower moving pests such as slugs or colorado potato beetles.
- Use traps to collect earwigs and slugs. Collect earwigs in rolled up newspaper or any form of tubing and dump into a bucket of soapy or oily water. Place trap material in and around the garden at night and collect insects in the morning. Shallow dishes of stale beer will attract slugs.
- Encourage the presence of beneficial organisms. In addition to beneficial insects such as lady beetles and ground beetle, birds, frogs and toads, spiders and even snakes can be helpful in controlling pest problems.
- Plant a variety of companion flowering plants to provide pollen and nectar as an attractant for insects such as parasitic wasps and flies.
- Some insects such as aphids and mites can be removed from plant surfaces with a strong spray of water from the garden hose.

Chemical Control

Use pesticides only when necessary and apply to only the plants affected. Spray only in calm weather to avoid spray drift.

When the use of a pesticide is unavoidable, know the product to be used. Read the entire label and know the insects controlled by the product in use. Use only the recommended rate, wear protective clothing such as rubber gloves, pants, and rubber boots, and apply in calm weather. Wash hands and exposed skin after mixing and after application. Prepare only the amount of pesticide required for that particular application. This eliminates the problem of what to do with left over material and reduces the temptation to give the plants a 'double dose'.

All home garden pesticides have a days to harvest notice on the label. This specifies the period of time which must lapse between the last application of the pesticide and the day the vegetable may be harvested. This will vary for each pesticide and between vegetables for the same pesticide. Be sure to read the label.

Pesticide Selection

To choose the proper pesticide for control of a pest problem, it is important to know the type of organism and the best method by which it can be controlled.

Insecticide Characteristics

In general, insecticides can be classified as either contact or systemic in nature.

- A contact insecticide controls the insect pest through direct contact and absorption of the spray (at application) or by contact with the insecticide residue, or by ingestion of the insecticide by the insect.
- A systemic insecticide is absorbed by the plant tissue and temporarily becomes a part of the plant. It is translocated to other parts of the plant including plant tissue that develops after insecticide application. Systemic insecticides control insect problems for a longer period of time than contact insecticides as they are not washed off by rain-fall.

Insect Characteristics

Insect pests are characterized into two basic groups, those with chewing and those with piercing-sucking mouth parts.

- Chewing insects feed on the exterior portions of the plant. Damage appears as holes in the foliage, flowers, or fruit and can vary from small 'shot-holes' to entire defoliation of the plant. They can be controlled with either contact or systemic insecticides. Some chewing insects such as leaf miners and borers feed on the internal tissue of the plant in the larval form and must be controlled with a systemic insecticide. The adults may be controlled with a contact insecticide at egg laying time.
- Insects with piercing-sucking, mouth parts, pierce the plant surface and suck the internal sap of the plant. The damage may appear as minute, discoloration of the foliage, curling of the foliage, deforming of fruit, and if severe wilting and death of the plant. Piercing-sucking insects are also carriers of several diseases common to vegetable crops.

Fungicide Characteristics

Fungicides can also be categorized into two distinct types: protectants and systemics.

- Protectant fungicides must be applied to provide a complete barrier to disease entry by forming a fine film over the surface of the plant They cannot control a disease once it has entered the plant tissue and therefore must be applied at the first sign of disease. They protect only the portion of the plant sprayed and can be washed off by rain-fall.
- Systemic fungicides, upon application become temporarily a part of the plant. They also provide longer protection. Systemic fungicides should not be used in exclusion of other fungicides as disease organisms have a greater ability to build up resistance to systemics.

Kinds of Formulations

Pesticides for insect and disease control in the home garden are available in a number of forms which include dusts, granules, baits, wettable powders, flowable formulas, and emulsifiable concentrates.

Dusts: Dusts are composed of finely ground inert material such as clay or talc and a low concentration of the active ingredient (the actual pesticide). They are usually available in a container from which they can be applied directly to the plant.

Granules: Granules are composed of larger particles of inert material and a low concentration of the active ingredient. They are usually applied to the soil for the control of soil insect pests such as cutworms, wireworms, and root maggots.

Baits: Baits are composed of a food substance impregnated with an active ingredient and compressed into a pelletized form.

Wettable Powders: Wettable powders are composed of inert material impregnated with a wetting agent and the active ingredient. They must be mixed with water to be applied. In water, the material becomes a suspension. To keep the material in suspension, the sprayer must be agitated or shaken often. If this is not done, the material will settle out and an uneven application and clogged nozzles may result.

Flowable Formulation: Flowable formulations contain the active ingredient as fine particles which dilute in water. They also must be mixed with water for application.

Emulsifiable Concentrate: Emulsifiable concentrates contain the active ingredient in a solvent. They dissolve easily in water and are easy to mix for application.

Insecticides and Fungicides for the Home Garden

There are a number of insecticides and fungicides available to the home gardener. Most are available in different formulations and can be used to control a number of insect and diseases. Some are specific to a small number of pests. To use properly it is important to know the mode of action of each and the pests controlled by each product. See Tables 15 and 16 for a listing of the products and the pests they control.

Insecticides

Organic or Natural and Biological Insecticides

Organic insecticides are materials which are derived from natural sources. Biological insecticides are micro-organisms or the biproduct of micro-organisms, which kill specific insect species.

Rotenone: Rotenone is a derived from derris and cube roots. It is a contact insecticide and controls through direct contact or by ingestion. It has a very short residual time. While it has a moderate toxicity to mammals, except swine, it is highly toxic to fish species and should be handled with care around open water. It however, is not harmful to bees.

Pyrethrum: Pyrethrum is derived from the chrysanthemum flower. It is a contact insecticide and

controls by direct contact or by ingestion. It has a long residual time but is less effective at high field temperatures above 25°C.

Diatomaceous Earth: Diatomaceous earth is composed of the skeletal structure of microscopic marine organisms. It is a contact insecticide which controls by direct contact or ingestion. It has an abrasive surface which damages the tissue of ingesting organisms causing dehydration. Avoid inhalation. Works only under dry conditions.

Bacillus thuringiensis: Bacillus thuringiensis (B.t.), is a biological insecticide. It is the byproduct of a bacterial organism which controls several caterpillar species. It has a short residual time and must be ingested to be effective. It is not harmful to humans, pets or bees.

Synthetic Insecticides

Synthetic insecticides are those which are synthesized and are either contact or systemic in nature.

Carbaryl: Carbaryl is a contact insecticide which controls by direct contact or by ingestion. It has a short residual time. It is very toxic to bees.

Chlorpyrifos: Chlorpyrifos is a contact insecticide which controls by direct contact or ingestion. It is often used as a soil insecticide and has a relatively long residual time.

Diazinon: Diazinon is a contact insecticide which controls by direct contact or ingestion. It is also used as a soil insecticide and has a relatively short residual time.

Dimethoate: Dimethoate is a systemic insecticide. It controls by direct contact or ingestion and has a long residual time in the plant.

Insecticidal soap: Insecticidal soap is a contact insecticide composed of a fatty acid based soap. It controls by direct contact only. (It's formulation is different than regular detergent soaps which can burn the foliage of plants and should therefore not be used as an insecticide.)

Malathion: Malathion is a contact insecticide which controls by direct contact or by ingestion. It is not effective at low temperatures and should not be used early in the garden season.

Methaldehyde: Methaldehyde is a contact mollusicide for the control of slugs and snails. It causes desiccation of the slimy, protective coating of these pests.

Methoxychlor: Methoxychlor is a contact insecticide which controls by direct contact or ingestion. It has a long residual time.

Permethrin: Permethrin is a contact insecticide which controls by direct contact or ingestion. It has a long residual time and is less effective at high field temperatures above 25°C.

Fungicides

Captan: Captan is a protectant fungicide. It has a broad spectrum of activity.

Chlorothalonil: Chlorothalonil is a protectant fungicide. It has a broad spectrum of activity.

Copper: Fixed copper is a protectant fungicide. It will also control some bacterial organisms. It may cause burn to some plant foliage.

Maneb: Maneb is a broad spectrum, protectant fungicide.

Oxine benzoate: Oxine benzoate is a soil applied, protectant fungicide for the control of some damping-off organisms.

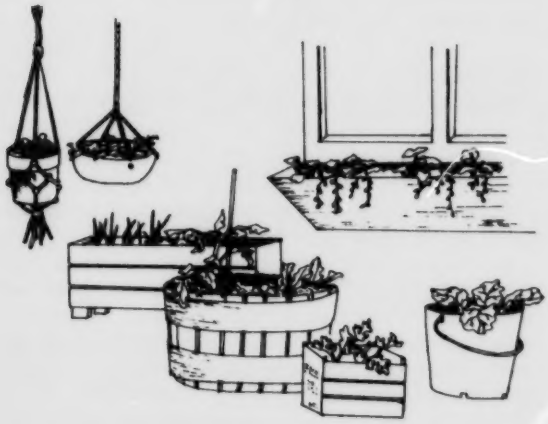
Zineb: Zineb is a broad spectrum, protectant fungicide.

While some insecticides and fungicides, by their nature, have a longer residual time than others, weather conditions do become a factor in the effectiveness of most products. Under relatively dry conditions, a period of 7 to 14 days may lapse between applications while a period 7 days or less between applications may be required in wet weather to control pest problems.

Container Gardening:

For those limited by garden space, container gardening is an option. All that is required is light, water, a container full of growing media, fertilizer, and some loving care.

The type of container used need not be complicated and can vary in form from buckets, barrels, or a large garbage pail, to large planters or window boxes or containers especially constructed for container gardening. In general it should be 20-25 cm deep, have drainage holes, and be sturdy enough to avoid being blown over in windy weather.



Many crops can be grown in container gardening. A number of new compact, bush varieties are available which do well in the limited space and soil restrictions of container gardening. The best crops to be grown in containers are crops which provide a high percentage of edible tissue (the plant itself or fruit) in relation to the actual size of the plant. Such crops include beans, cabbage, carrots, cucumber, eggplants, garlic, leaf vegetables (lettuce, spinach, swiss chard), melons, peas, peppers, onions and leek, tomatoes, zucchini, and herbs. Vining crops grown in container can be grown on a trellis to improve space efficiency. While crops which produce a lot of foliage and only a small portion of edible harvest (ie. sweet corn and Brussels sprouts), are possible to grow in containers, inefficient usage of space is made.

The growing media should be a fairly light mixture which provides drainage and does not become compacted. It is best to use a soil-less blend or combine garden soil with peat moss and vermiculite or perlite rather than using a straight garden soil.

Fertility and moisture management are important in container gardening. Check daily for water requirement. During the hottest days of the summer, it may be necessary to water twice per day as the limited volume of soil within the container will dry out more rapidly than the normal garden soil. While hoses and/or watering cans work well, large container gardens could be more efficiently managed with a spaghetti tube irrigation system. Because of the frequency of moisture application, there will be greater tendency of nutrients to leach from the soil. Be sure to start with a good fertile soil mix and apply additional nutrients on a weekly basis throughout the growing season.

Many gardening books and publications are available which provide additional information on container gardening including crop management and variety selection, as well as container construction ideas. See References, page 46 for suggestions.

Container Selection Tips:

- Use wide-bottomed containers to prevent wind damage.
- Light weight containers and window boxes should be anchored or bolted into place.
- Use light colored containers which reflect the sun. This keeps the soil cooler and slows down the speed at which the soil drys out.
- Increase the weight of containers with heavy drainage materials such as gravel in the base of the container.
- Remove the growing media at the end of the growing season and clean the container. Remove all soil and plant particles and wash the container with soapy water. Soak in a mild bleach solution to reduce the chance of disease carryover.

Crop Management Tips:

- Use a light growing media composed of three parts peat moss, one part coarse sand, and one part perlite or vermiculite or one third garden soil, and two thirds peat moss, sand and vermiculite.
- Check daily for water requirements. If the soil is dry, water until there is water coming from the drainage holes.
- To conserve water, apply a 2.5 cm layer of compost, leaf mold or vermiculite or perlite. Avoid peat moss. Once dry, it can act as a wick and remove rather conserve moisture.
- Nutrients will leach out more readily due to frequent watering requirements. Add a good supply of nutrients to the growing media at the beginning (compost, or slow-release granular fertilizer). Supplement with weekly applications of compost or manure tea, or water soluble fertilizer.
- Select compact, bush type varieties or the more recently developed dwarf and midget varieties.
- Vining types of vegetables such as pole beans, cucumbers, melons, squash, tomatoes, and peas can be grown in containers but must be grown on a trellis. Begin training the crop onto the trellis early in the growth stages of the plant (20-25 cm in height). Plastic netting is best. Use small mesh (3.75 × 3.75 cm) for peas and beans and 10-15 cm sq mesh for vine crops and tomatoes.
- More than one crop can be grown in the same container so the principles of companion planting, intercropping, and double cropping apply easily to container gardening. Leafy or trellised vegetables can be easily combined with root crops. Rapidly growing crops (leaf lettuce, spinach, radish) can be double cropped with slower, later maturing varieties.

Vertebrate Pests:

A number of vertebrate pests can be a problem to the home gardener. These include raccoon, deer and moose, woodchucks, porcupines and birds (crows, black birds, pheasants, and starlings). Damage can occur throughout the gardening season. Depending upon the visitor, damage can occur to almost any vegetable or be limited to a select few. The earliest damage is usually caused by birds and results in the pulling out of seed or newly emerged seedlings. Deer and Moose (in Newfoundland) feed on the foliage of almost any crop. Leafy vegetables, squash, and tomatoes are favored by woodchuck. Sweet corn, ready for harvest is the target of raccoons, porcupine and birds.

A number of control methods are available to the home gardener and are specific to each vertebrate pest group.

Deer:

Home gardens located close to the house are not usually visited by deer. However, for gardens which are more isolated, control methods including high fencing (at least 2.5 m high), various types of electric fencing (see suggested readings page 46) visual repellants (plastic bags on posts), noise makers or radios, and odor repellants (human or dog hair or bloodmeal) may be required to minimize damage. A dog may also help.

Raccoons, Woodchuck and Porcupine:

Fencing is one method of control. However, electric fencing (with the wires located 12 and 25 cm from the ground) is more effective than other fence types but may be considered impractical or unsafe for the home garden. Chicken wire is one option. Use 2-3 m wide chicken wire and bury the bottom 25 cm into the soil on an outward slant. Other methods of control include live trapping or the placement of dogs in the garden at night. A frequently used method to deter raccoons in sweet corn is the planting of squash or pumpkins between or beside the rows of sweet corn.

Birds:

A number of methods are available to deter the visitation of nusiance birds in the garden. Recently developed ultrasonic or electronic sounding devices such as 'Scareaway' are now available to the home gardener. A number of visual devices are also quite effective in reducing bird visitation. They include whirlers, streamers, spinners, reflectors (aluminum pie plates), 'Scare-eye' balloons, plastic hawks or owls, and of course scare crows. Physical barriers can also be used and include polyethylene, nylon, or cotton netting or even paper bags placed over each ear of corn (after the silk has turned brown).

Common Garden Insects

CUTWORMS

Plants Attacked

All vegetables, especially seedlings and transplants.

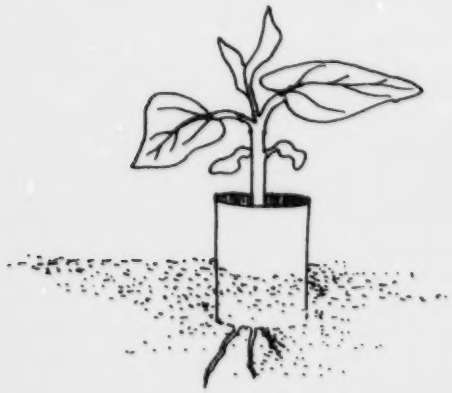
Injurious Stages and Type of Injury

Cutworms are fleshy soft-bodied, night feeding caterpillars ranging in length from 4-6 cm. There are several species of cutworms. Cutworms are present in the soil during the spring planting season and damage can occur as soon as transplants are set out or seedlings begin to emerge. Cutworms return to the soil during the daytime and are easily found just below the soil surface in a curled up position. They can usually be found close to the plant stalk.

Injury occurs early in the growing season from late May to late June. Seedlings and transplants are cut off at or just below the soil surface. Some species, such as the variegated cutworm, climb the stalks and feed on the plant foliage at night, returning to the soil in the daytime.

Control

Protect plants at transplant time by placing cylinders made from tar paper or cardboard, or from tin cans, milk cartons, or plastic dishes with the bottoms removed, around each plant. Sink the bottom rim into the soils approximately 2 cms.



When damage is found in closely spaced, direct seeded crops, scratch the soil around the chewed off plants to find and eliminate the culprit.

Gathering cuttings and crop residues at fall clean-up will reduce the incidence of damage the following year.

ROOT MAGGOTS

Plants Attacked

Several vegetable crops are affected by various species of root maggots including the carrot rust fly, the onion maggot, and the cabbage maggot. Crops affected include cabbage, cauliflower, broccoli, turnips, carrots, parsnips, onions, and radish.

Injurious Stages and Type of Injury

Root maggots cause severe damage to crops throughout the growing season. Most species of this insect problem have two to three generations per year. The first generation occurs from mid-May to early June, the second in August-September, and the third in late Sept. Maggots, the larvae of adult flies are whitish in color, approximately 8 mm. in length. They are legless, with one pointed (the feeding end) and one blunt end.

Adult flies are similar in appearance but slightly smaller than houseflies. For all species, eggs are laid by the adult fly, at the soil surface beside the host crops. The larvae emerge and burrow into the root area of the crop.

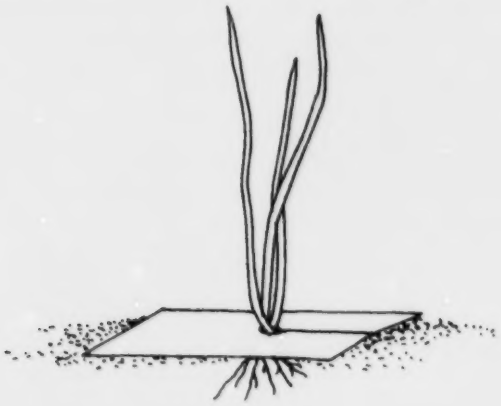
In root crops such as carrots, radish, turnips, rutabagas, and onions the maggots tunnel along the surface of and into the vegetable, making winding open scars and rough corky surfaces. Damage can range from minor, removable damage to total destruction of the root. Both generations of root maggots can be a problem for root crops. Early spring damage will destroy crops. The second generation can cause major tunneling along the surface and into the root of the crop. Severe tunneling will make the roots unusable and decrease storage life as organisms which cause storage rots will enter the damaged areas and cause breakdown.

In cole crops, the maggots feed on both the feeder and the main root areas. Affected plants become stunted and turn bluish-grey. Leaf edges tend to curl and wilting will occur in hot dry weather. Affected seedlings and transplants will usually die. For young transplants, the first generation is the most destructive. Older plants can survive but growth and yield will be affected.

Control

To prevent injury, delay planting until mid-June to avoid the first generation of root maggot flies. Transplants can be protected by a tar paper or plastic 'collar' placed at the base of each plant. The collar should be about 10 by 10 cm in size with a small hole in the center and a slit to one side for sliding the collar around the stem. The collar should lay flat on the soil surface to prevent the fly from laying eggs next to the plant. To reduce over-wintering, destroy affected crop debris and practice a three year crop rotation between

crops affected by the same root maggot species. Fabric row covers can also be used as a barrier to prevent the fly from reaching the target crop. The covers are placed over the crops at planting and can be left on until harvest. They can by removed for weed control purposes.



Infestation levels of the second and third generation are usually not as high and the level of damage occurring is dependent upon the crop. Cole crop roots will be affected but the plants will not die. Root crops will be more seriously affected as feeding damage will disfigure the vegetable and affect the storage life of the crop. Proper sanitation and good control of the first generation will reduce the incidence of second generation problems. On carrots, turnips and rutabagas, minor damage can be removed during food preparation.

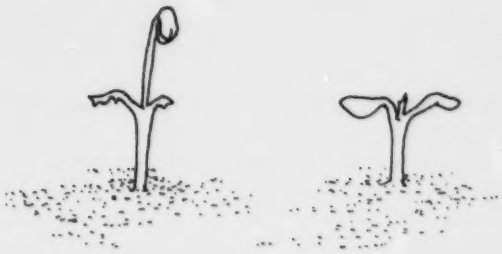
SEED CORN MAGGOT

Plants Attacked

Large seeded vegetable crops such as corn, beans, and peas.

Injuries Stages and Type of Injury

The seedcorn maggot attacks either the seed preventing germination, or the germ of the emerging seedlings. The seedcorn maggot, like other root maggot insects is the larvae stage of an adult fly. Eggs are laid in June, on the soil surface. The adult fly is more attracted to recently manured soils or soils high in organic matter. The larvae hatch and burrow into slowly germinating seeds or feed on emerging seedlings. Affected seeds will not germinate. Affected seedlings may break through the soil surface but will not develop leaves and are referred to as 'snakeheads.' Damage is greatest during cool, wet spring periods of poor germination.



Control

As the fly is attracted to high levels of fresh organic matter, avoid spring applications of manure when planting peas, beans, and corn. When seeding in cool spring soils, seed shallow to encourage quick germination and if possible, delay seeding of beans and corn until the soil warms up. Use treated seed to reduce the potential problem.

LEAF MINERS

Plants Attacked

Fleshy leaf vegetables such as spinach, beets, and chard are susceptible to attack from leaf miners.

Injuries Stages and Type of Injury

The leaf miner attacks the leaves of susceptible vegetable crops through-out the growing season. Damage appears as light colored, irregular blotches, blisters, or tunnels in the leaves. The two layers of the leaf in the damaged areas can be easily peeled apart. The damage is caused by members of a family of leaf-mining flies. The tiny adult fly lays its eggs on the undersurface of the leaves. When the eggs hatch, the tiny maggot-like larvae bores into the leaf. They tunnel between the upper and lower layers of the leaf, feeding on the inner tissue creating the tunneling and blotches. The life cycle is short and generations can overlap resulting in leaf miner infestations throughout the season.

Control

Little can be done to control the leaf miner once it is inside the leaf. Severely damaged leaves should be picked and removed from the garden area to reduce further infestations. Leaf miners are also attracted to the 'lambsquarter' weed. Keep the garden area free of this weed to reduce infestation. Fall cleanup of debris can also reduce problems the next year. In leaf crops such as spinach and chard, minor damage can be removed during food preparation. The beet root is not affected. The New Zealand type spinach are less susceptible to leaf miners and can be grown if leaf miners are a yearly problem.

APHIDS

Plants Attacked

Nearly all vegetable crops are susceptible to injury from aphids.

Injurious Stages and Type of Injury

Aphids, or plant lice, are small, soft-bodied, pear-shaped insects. They are often found in large clusters on the stems and leaves of plants and can vary in color from green, red, pink, brown, gray, or black. Both the nymph (immature) and the adult stage of the insect feed on plants. Aphids cause plant injury by sucking the sap from the plant. Heavy feeding by aphids will cause stunting and deformation of buds, flowers and new shoots; and curling, puckering, yellowing, and withering of leaves. Aphids also excrete a sticky substance known as honeydew which is an attractant to ants. Aphids can transmit plant virus diseases while feeding. Aphids can be either winged or wingless and are spread from plant to plant by wind, water, and by people. Winged generations will appear if infestations become too great on the present host. The winged aphids will then move to neighboring plants.

Control

Control should begin as soon as the insect is found as populations can build rapidly under favorable conditions. Light infestations can be removed with a strong spray of water (from the garden hose). Aphids are a favorite food of ladybugs and lacewings. If possible, avoid spraying to allow populations of the beneficial insects to build up to control the aphids.

SLUGS

Plants Attacked

The foliage and fruit of nearly all vegetable crops is susceptible to injury from slugs.

Injurious Stages and Type of Injury

Slugs are not insects rather they are members of the Mollusc family. They are soft-bodied, grayish to grayish-black in color and can range in length from 0.3 to 10 cm. Because of the need to stay moist, slugs are covered with a slimy coating and avoid direct sunlight by hiding during the day in cool damp locations. The eggs are laid in the soil or in protected areas (under boards or debris) and are encased in a slimy, protective mass. They overwinter as eggs in the soil or in as adults in protected areas. Overwintered eggs hatch in the spring into miniature sized slugs and feeding begins. Slugs feed at night or in cloudy, wet, weather. Damage can be found throughout the growing season on any part of the plant such as the foliage of young seedlings, the fruit of ripe tomatoes, or on the sprouts of Brussels sprouts. Damage to foliage appears as irregular holes with smooth edges chewed into the leaf. A silver trail found on the plant and surrounding soil is evidence of slug presence. Affected fruit will have holes chewed into its sides. Fruit laying directly on, or close to the soil surface, are most susceptible to injury.

Control

Slugs are a greater problem in damp, shady gardens or during prolonged periods of wet growing conditions. Remove vegetative trash and crop debris during the growing season to eliminate hiding and overwintering places. Avoid heavy applications of organic mulching materials in shady garden areas. Slugs will also hide in the grass at the edge of the garden. Keep the grass cut short close to the garden and leave a 25 to 30 cm band of cultivated soil along the garden edge. Materials which can penetrate the slugs slimy protective coating, can be used as barriers to protect plants against slug damage. These materials can be placed around the garden perimeter or around individual plants and include such items as egg or seashells, wood ash, or diatomaceous earth. Planks can be placed on the ground between the rows to act as traps for slugs. Lift the planks each morning and collect and destroy the slugs. Stale beer in shallow dishes, placed in the garden each evening can act as attractant for slugs luring the beasts to a watery grave. If commercially available slug bait is used as a control method, it should be protected from rain and heavy dew to lengthen the lifespan of the pellets. To make a 'bait station', cut four or five, 10 to 15 cm deep triangles around the rim of a 4 liter plastic container. Place the lid of a smaller sized container on the ground and place the bait pellets on the lid. Invert the 4 liter container and place over the bait. Sink the edge of the container into the ground approximately 5 to 8 cm. Bait stations will also protect children, pets, and wildlife from the bait pellets.

COLORADO POTATO BEETLE

Plants Attacked

Potatoes, eggplants, and tomatoes.

Injurious Stages and Type of Injury

Both the larvae and the adult beetle feed on the foliage of potatoes, tomatoes, and eggplants and damage can occur throughout the growing season. Uncontrolled, complete defoliation of the plants will occur. The larvae are humped backed, brick-red in color, with two rows of black spots on each side. The adult

beetles are hard-shelled, about 12 mm. in length, with longitudinal yellow and black stripes. The adult beetle overwinters in the soil, emerging in the spring just about the time potatoes are emerging and tomato transplants are being set out in the garden. Eggs are laid on the underside of the leaf in small clusters. Larvae begin to feed as soon as they hatch, completing development in about two weeks. Two generations per year can be expected.

Control

The beetle overwinters in the soil, so crop rotation is important for control. Hand pick the early spring generation. Control can also be obtained by timing of planting and varieties grown. Planting early with a short season variety will avoid the second generation while planting late with a short season variety will avoid the first generation.

FLEA BEETLES

Plants Attacked

Potatoes, tomatoes, peppers, eggplant, cole crops, radish, turnip, and rutabaga.

Injurious Stages and Type of Damage

Flea beetle damage occurs in early spring and midsummer. The small, shiny black beetles are about the size of the head of a pin. They can be seen jumping around the affected plants like fleas. Flea beetles chew small, circular holes in the leaves and can destroy much of the leaf surface.

Control

Although damage may appear severe, healthy, fast-growing plants will normally outgrow the damage. Heavy infestations however, can destroy seedlings and transplants, so they should be protected.

EUROPEAN CORN BORER

Plants Attacked

Although the greater problem in sweet corn, this insect also attacks potatoes, tomatoes, peppers, and beans.

Injurious Stages and Types of Injury

The European Corn Borer can be a destructive pest of sweet corn. The eggs are laid in clusters of 15-30 eggs by the night flying adult moth on the underside of the leaf. Egg laying usually begins in early to mid July.Newly hatched larvae are approximately 1.5 mm. in length with a black head and a pale colored body. They begin feeding immediately on the leaves causing small 'shothole' type damage. The young larva can usually be found in the tassels. A 'sawdust' like residue on the tassels or broken tassels are indicators of corn borer presence. As the larvae get older, they bore down into the stalk and eventually into the ear of corn. Weakened stalks will break easily in the wind. Affected ears of corn will show feeding damage, most often on the bottom region of the cob. Mature larvae are approximately 2.5 cm in length and are dirty-white to pinkish in color with a dark head and two rows of brown dots running lengthwise down the body. Feeding lasts for about one month.

Control

Once the larvae enters into the stalk or the ear of corn, little can be done to control the problem. The only alternative at that time is to remove the damage portion during food preparation. Some control can be obtained through fall sanitation and careful monitoring during the growing season. As the borer can overwinter in the stalks, remove all corn stalks from the garden area each fall and practice crop rotation. Begin watching during evening hours in early July (about the time the corn is at the 8-10 leaf stage and/or is just beginning to show tassels) for a small buff colored moth and check the underside of the leaf for egg clusters. The egg clusters will resemble fish scales and are usually found close to the midrib of the leaf. Eggs will hatch in 3-4 days and will move quickly to protected areas of the plant. Therefore if control methods are to be used, application must be within a day of hatching. Apply control insecticides to the leaf surfaces and into the center whorl of the plant. continue monitoring, and apply again as required. Apply in the evening to prevent honeybee injury.

CORN EARWORM

Plants Attacked

Sweet Corn and tomatoes.

Injurious Stages and Type of Injury

The corn earworm is the second serious sweet corn insect pest in both degree of injury and time of infestation. Unlike the borer which attacks the leaves, the stalk, the tassels and the cob of the corn plant, the corn earworm is a problem in only the ear of the corn. The corn earworm flies into Canada each year from overwintering areas in the U.S. usually arriving in Atlantic Canada in early August. The moths are most active at night and one female moth can lay between 500 to 3000 eggs.The eggs are laid on the silks of the corn ear. The eggs hatch in about 3 days. The larvae feed on the silks and travel downward inside the husks where they feed on the tip of the corn ear. The mature length is 3.3 to 5 cm and can range in color from bright green or pink to brown or black. They have a light colored head and alternating light and dark lines run lengthwise down the sides. Usually only one earworm is found inside the corn husk as cannibalism is common.

Control

Control is difficult due to the unpredictable life pattern and protected feeding location (inside the husk). Monitoring is difficult due to the nocturnal flying habit of the adult moth and the difficulty of finding the tiny eggs in the silks. If watching for the moth, check the corn patch in late evening for a light, orange-brown

moth flying among the corn plants. Early maturing varieties, planted as soon as spring soil temperatures permit, may mature before the earworm becomes a problem. Varieties which have good tip cover by the husk are somewhat less susceptible to injury. Some control can be obtained by applying a drop of mineral oil to the silks just as they appear. This however can be time consuming and must be repeated as more silks appear and the silks emerge further from the tip of the ear. The only option left may be to cut the damaged tip off during food preparation.

IMPORTED CABBAGEWORM

CABBAGE LOOPER

DIAMOND BACKED MOTH

PURPLEBACKED CABBAGEWORM

Plants Attacked

Broccoli, cabbage, cauliflower, turnips, rutabagas, and Brussels sprouts.

Injuries Stages and Type of Injury

The larvae (caterpillar) of the first three insect pests are similar in appearance and in the type of damage caused and are frequently confused. Damage can occur anytime from May to October and varies from small to large irregular holes in the leaves and on the surface of cabbage heads. The feeding results in large masses of greenish to brown droppings, which are annoying and cause discoloration on cauliflower heads. Perhaps the most annoying habit of these insects is their tendency to crawl into the center of the broccoli heads to feed where they become almost impossible to find. Of the three species, the Imported cabbageworm is the best known. Unlike the night flying diamond-backed and the cabbage looper moths, the creamy white imported cabbageworm butterfly, flies about in the daytime depositing yellow bullet-shaped eggs, singularly on the underside of the leaf. The larva is velvety, leaf-green in color, slow moving, and can be as long as 3 cm in length at maturity. The sides of the body are marked centrally with an orange stripe. The cabbage looper is similar in appearance. It is slightly larger (4 cm) at maturity and is distinguishable from the cabbageworm by a thin white stripe which runs down the back and sides of the caterpillar. It is most distinguishable by it's 'looping' movement as it crawls along. The smallest of the three caterpillars is the Diamond-backed moth. This small green worm feeds on the undersurface of the leaf making small and transparent holes in the leaf. When disturbed, they wiggle about quickly and/or drop from the plant on a silk thread. The purplebacked cabbageworm is a less common pest. The larvae of this insect is purple on the back and pale yellow on its sides. They can be a problem in high numbers and damage caused is similar.

Control

Damage from these insects can occur anytime between May to October. The caterpillars can be hand picked if not too numerous. Crops covered with fabric row covers for protection from cabbage maggots will also be protected from the caterpillars. Watch for the moths and apply the chemical control products as soon as the tiny larvae caterpillar appear.

EARWIGS

Plants Attacked

All vegetables. More severe in leafy crops.

Injurious Stages and Type of Injury

Earwigs, although a nuisance, are not a major pest of vegetable crops. Earwigs, like slugs, feed at night and hide during the day. Although earwigs feed mainly on decaying plant material and other insects, they will feed on leaves causing small, irregular holes or skeletonizing the entire leaf. They become a nuisance when they hide in the plant leaves and are brought into the house at harvest or as they rush about the garden when disturbed. Earwigs are easily identified. The adult is about 10-12 mm long, dark reddish brown in color with long pinchers protruding from the rear of the body. (Males and females are easily distinguishable by the pinchers. On the female, the pinchers are straight-sided while the males pinchers are caliper-like in shape.) They have wings but do not usually fly. Because of their tendency to hide in any available shelter they are easily transported from place to place, by people. Earwigs overwinter in the top 5-15 cm of soil. Earwigs can be present in April (depending on the temperature) and are most serious from June onward.

Control

Earwigs can be found anywhere on the property and do not isolate themselves to the vegetable garden. Therefore, "full property" control is required. Clean up all debris to eliminate hiding places. Earwigs hide in the daytime. They can be collected in traps and disposed of each morning. Place traps around the property as well as in the vegetable garden. Traps can range from rolled up or folded newspaper, metal tubing, bamboo canes, to flower pots with some tissue paper in the bottom placed upside down on stakes. To dispose of collected earwigs, dump collected bugs in a pail of water containing some soap or oil. Numerous baits are available and can be used in the garden area. Non-poisonous baits which can be made at home are also effective. Shallow dishes, partially filled with fish or other edible oils, buried to the rim in the soil are excellent controls. Control should begin in early June when earwig are young. Soapy water may be used generally around the home especially in non crop areas where earwigs hide (to keep earwig populations down).

POTATO STEM BORER

Plants Attacked

Potatoes, sweet corn and rhubarb.

Injurious Stages and Type of Injury

The pinkish-white larvae of the potato stem borer bores into the plant stalk. This insect overwinters as eggs laid in August. They hatch the following June and cause damage during the months of June and July. In sweet corn, the larvae tunnel into the young plants at the soil surface.Affected plants will appear wilted, break off, and die. In potatoes, they bore into the stalk and weaken the plant. In rhubarb,they bore into the stalk and feed on the interior of the stalk. Affected stalks will excrete a clean jelly-like substance.

Control

As the insect overwinters as eggs on the stems of grasses, crop control of couch grass is an effective method of control in sweet corn and potatoes. Avoid planting susceptible crops in affected areas two years in a row. Keep rhubarb plantings as free of weeds and grass as possible. Keep an area of bare soil between the rhubarb planting or the garden and any adjoining lawn area.

WHITE GRUBS

Plants Attacked

The roots of young seedlings and transplants as well as tubers are susceptible to injury from white grub.

Injurious Stages and Type of Injury

White grubs are the larvae of the June beetle. They have cream colored bodies and a brown head and are usually found tightly curled in the soil. They are most commonly a problem in newly established gardens which were in sod the previous year. They feed on the roots of most vegetables and some small fruit crops. Plants will appear wilted and die. White grubs will also feed on tubers of potatoes.

Control

Prevention is the best method of control. Whenever possible, cultivate sod land one year before planting and keep the area worked and the soil bare for that year.

ONION THRIPS

Plants Attacked

Onions and leeks.

Injurious Stages and Type of Injury

The adult and larvae of the onion thrip feed on the leaf tissue of the onion and leek. Thrips are very small (1 mm.), slender, yellowish to brown insects which may be winged or wingless. They feed on the tissue by rasping the surface and sucking the sap of the plant. Damaged leaves take on a silvery, streaked appearance.

Control

Keep the garden area free of weeds and remove crop debris after harvest.

SPIDER MITES

Plants Attacked

Beans, peppers, tomatoes, and eggplants.

Injurious Stages and Type of Injury

Spider mites are not true insects in that, like spiders they have four pairs of legs and belong to the class Arachnida. Spider mites are very minute in size. Due to a short life cycle of 7 to 10 days, there are many generations per year. They have sucking mouth parts and feed on the sap of affected plants. The upper surface of affected plant leaves will appear speckled, yellowish-green in color, and puckered. On the underside of the leaf, minute yellow, green, or red specks may be visible on close observation. Webbing may also be present on the underside of the leaf or between the leaves. Mites are active throughout the growing season but will be most severe during periods of hot, dry, weather conditions.

Control

Spider mites are difficult to control culturally, although regular watering will prevent stressful conditions to the plants which make the plants more susceptible to infestation. Insecticidal soap is an effective control but must be applied 3-4 times within a two week period to ensure that all newly hatched mites are controlled.

FALL ARMYWORM

Plants Attacked

Sweet corn.

Injurious Stages and Types of Injury

The larvae of the fall armyworm is a light tan to dark-brown colored caterpillar with yellow, orange, or dark brown stripes. The adult moth is migratory, overwintering in Central America. They appear in the Atlantic region anytime after late June. The night flying moth lays the eggs on the blades of grasses, grains and corn.The hatched larvae feed in the whorl and on the leaves causing large holes and a tattered appearance to the plant. The caterpillar will also enter the tunnels of the corn borer and feed on the interior of the plants. Some injury can also occur to the cob.

Control

Keep the area as free of grassy weeds as possible to reduce the potential for egg laying. Monitor corn for insects and collect the larvae or apply control if the infection is severe.

WIREWORMS

Plants Attacked

Wireworms feed on the seeds and roots of many vegetable crops.

Injurious Stages and Type of Injury

Wireworms are the larval stage of the click beetle. The shiny, segmented, hard-bodied, yellowish-brown to dark brown colored worm is found in the soil and can be 2 to 4 cm in length. Eggs are laid in the soil. Hatched wireworms will feed for 2 to 6 years before maturing so varying sized worms can be found. They feed on underground plant parts, including seeds, root, underground stems, and tubers. They feed on many crops, including carrots, corn, turnips, rutabagas, beets, beans, peas, lettuce, and potatoes. The damage caused will depend on the type of crop or the plant part affected. Seeds will be destroyed. Plants whose roots have been affected will be stunted and grow slowly. Crops such as turnips, rutabagas, potatoes and beets will exhibit holes and tunnels in the sides of the roots or tubers. Wireworms are sometimes confused with the beneficial millipedes often found in the garden soil. Millipedes are the hard-bodied, cylindrical, brownish-black worm-like creatures that curl up into a tight coil when disturbed. They normally feed on decaying organic matter and will only feed on crop roots when present in high numbers.

Control

Wireworms are most serious in areas which have been in sod for a number of years. To reduce potential problems, begin garden preparation one year prior to planting the first garden. Remove any sod and keep the soil cultivated for one year before planting to reduce the population.

CUCUMBER BEETLE

Plants Attacked

Cucumbers, squash, melons, and pumpkins.

Injurious Stages and Type of Injury

The adult beetle is yellowish-green in color with dark stripes. The beetles overwinter in plant debris and weeds and feed on the stems and leaves of emerged or transplanted curcubit crops. Feeding can result in total plant destruction. These beetles can also carry two diseases of curcubits (mosaic and bacteria wilt) which could also damage or kill the plants. The beetle lays eggs in the soil, at the base of the curcubit plants. The grubs which hatch, feed on the roots and the stems below the soil level causing the plants to wilt or be stunted in growth.

Control

Control should begin early to avoid disease inoculation from the beetle. Remove crop debris during fall clean-up to prevent overwintering. The use of fabric row covers such as Reemay, placed over the crop at planting, will protect the plants from damage. Begin application of controlling insecticides as soon as the insect is noticed.

ASPARAGUS BEETLE

Plants Attacked

Asparagus.

Injurious Stages and Type of Injury

Two species of Asparagus beetle can be a problem to home gardeners. Both species can be present in early spring, feeding on the young shoots and fronds of the asparagus plant causing scarring of the spears. Damage can also occur to the ferns from feeding of both the adult and the larvae stage of the beetles. This late season damage, if severe, will reduce food reserves to the roots and decrease plant vigor the following year. The adult beetles will be either a metallic blue or black in color with yellow markings and a narrow red head or reddish orange in color with black spots. The hump-backed larvae are orange or slate-gray in color.

Control

Removal of ferns in the fall will help to reduce populations in affected plantings.

BENEFICIAL INSECTS

There are a number of insects which can be found in the garden that do not cause any crop damage and are in fact beneficial to the garden. Some insects such as bees and wasps act as pollinators to many crops and therefore aid in crop production. Other insects such as lady beetles, ground beetles, lacewings, and syrphid flies are predacious in that they feed on many of the destructive insects.

Lady Beetles

The lady beetle, or ladybug as it is most commonly called, is the best known of the predatory insects. Both the larvae and the adult beetle are beneficial as they feed on aphid, mites, scale insects and other soft bodied insect pests. It is estimated that one larvae can eat as many as 25 aphids an hour while an adult beetle can eat 50 or more aphids in one hour.

Although commonly thought to be red with black dots, the ladybug adult can vary in shades of orange, in the number of dots, and in size. Whatever the color, they have a rounded back and are flat on the underside. The larvae are flat, grayish with orange or blue spots, alligator-shaped insects with legs on the front half of the body. Unlike the adult, they have no wings. During pupation, the larvae attach themselves to the leaf of the plant and are often mistakenly thought to be harmful. The cigar-shaped eggs are laid in clusters which stand upright. One female beetle can lay as many as 1500 eggs in her lifetime.

Because the ladybug is such a voracious eater, high numbers of the pest population are required to maintain the ladybug. When numbers drop, the ladybug

population will either migrate to other areas or starve to death. Then, as aphid populations increase, the ladybugs will return. It may take some time for the ladybugs to get the aphid under control again, so be patient.

Lady beetles can be purchased from mail order supply houses and introduced into the garden. These insects, however, are collected from huge masses in areas where they hibernate and due to their tendency to migrate, may not stay in the garden when they are released. If introduction is attempted, be sure there is a sufficient pest population to maintain the lady beetle or try collecting lady beetles from other areas of the property and placing the 'local' beetles into the garden.

Lady beetles are as sensitive to chemical insecticides as the insect pests found in the garden and can therefore be destroyed by indiscriminate use of home garden chemicals.

Ground Beetles

Ground beetles, another beneficial insect frequently found in home gardens, are actually a large group of insect species. They range in size from .5 to 4 cm in length, and in color from shiny black to brown or iridescent green, blue or purple. They have a characteristic thin head which is narrower than the thorax (middle section), and move quickly when disturbed.

Both the adult beetle and its larvae feed on slugs and other insects. They feed at night and hide in the daytime under foliage, debris, and stones.

Although beneficial in the garden, this insect can become a problem in the home. As an indoor insect pest, ground beetles do not cause damage or get into food products but become a nuisance by its presence as they scurry across the floor, climb up the walls, or get into shoes and sneakers.

Syrphid Flies

A third, and less familiar beneficial insect, the syrphid fly, can aid home gardeners in the control of the aphids. The adult fly is similar in appearance to wasps and bees in that is is approximately 13 mm (1/2 inch) long with a banded yellow and black abdomen. The adult feeds on the pollen and nectar of flowers and usually is seen hovering around and darting between flowers. The larvae, the predacious stage of this insect, hatches from eggs laid close to developing aphid colonies. The larvae is a legless, mottled-gray to beige or light green colored maggot, varying in length from 1 mm to 13 mm. One larvae can consume hundreds of aphids during this stage of the life cycle.

Lacewings

Another insect beneficial in the war against aphids is the larvae of the lacewing. The adult of the lacewing can be up to 2 cm in length. They have long antennae and transparent green or brownish lace wings which are held over the body in a roof-like position. The predacious larvae is a small, flat, spindle-shaped, alligator-like insect, approximately 1.25 cm in length. They are yellow to gray with reddish-brown markings. Their jaws are sickle-shaped which aid in catching prey. Although aphids are their main meal, they will also feed on mealybugs, scales, and other small insects.

Predatory Gall Midge, Parasitic Wasp

Two other beneficial insect species which feed on aphids and may be present in the home garden are the Predatory Gall Midge and Parasitic Wasps.

As with the syrphid fly, the larvae stage of the gall midge is predatory to aphids with an estimated feeding rate of seven to twenty aphids per day in its two week feeding period.

Parasitic wasps require aphids, as they conduct the entire reproductive phase of their life cycle within the body of live aphids. The female wasp pierces the skin of the aphid and lays a single egg in the aphid. The larvae hatches within the aphid, feeds on the internal tissue, eventually causing death. The larvae then pupates within the dead aphid and emerges as adult fly.

Beneficial insects can be helpful in the control of home garden pests. It is important to monitor the garden area and be aware of the insect species present in the garden. Although a garden pest may be present, chemical control may not be necessary if sufficient numbers of beneficial insects are also present. The presence of beneficial insects can be encouraged by providing a variety of flowering plants in the garden which provide pollen and nectar to act as an attractant to adult flies and parasitic wasps, and by reducing pesticide usage by using pesticides only when necessary, such as when beneficial insects are not present or when numbers are too great to handpick, or by applying pesticides to only the affected plant and avoiding spray drift to other plants.

BLOSSOM END ROT OF TOMATOES, BLACKHEART OF CELERY

Blossom End Rot of tomatoes and peppers and Blackheart of celery are physiological disorders caused by a lack of calcium in the soil and/or an uneven moisture supply during the growing season. It is not caused by a disease organism.

Blossom end rot appears as a circular brownish, black leathery area on the bottom of the blossom and of the fruit. Secondary disease organisms can enter through damaged tissue and cause further breakdown of the fruit.

Blackheart of celery occurs in the youngest tissue of the celery plant (the heart). Affected tissue in the center of the heart dies and turns black while the outer, older tissue remains green. Secondary disease organisms can also cause further tissue breakdown.

Injury occurs gradually and is not usually visible until later in the season when the fruit is close to maturity. Tissue damage occurs when hot dry periods alternate with periods of heavy moisture which result in an uneven or deficient supply of calcium to the developing plant or when calcium availability is affected by excessive use of fertilizer. Periods of rapid growth can also increase the potential for problem development. As calcium is required for fruit tissue and cell wall development, the deficient tissue does not develop properly.

To prevent the development of blossom end rot, ensure there is an adequate supply of calcium in the soil (through the application of lime), and provide a constant supply of moisture throughout the growing season. A rule of thumb is 2.5 cm of water per week for good growth. Mulching the soil will also help to maintain adequate moisture levels. Foliar applications of calcium nitrate or calcium chloride, made periodically throughout the season may be required to prevent the development of blackheart in celery.

BORON DEFICIENCY

Boron, a micro-nutrient, is required by some vegetable crops for proper development and deficiency can cause serious problems in crop development.

The most common problems associated with boron deficiency are Brown Heart of turnips and rutabagas, hollow stem and stem discoloration in broccoli, browning of cauliflower curds, and Black Spot of beets. Of these crops, turnips, rutabagas and beets are most severely affected by boron deficiency.

Brown Heart can be found in turnip and rutabaga by splitting open a root where firm, water-soaked patches occur in the flesh. The tissue may eventually turn brownish and become pulpy and hollow. Affected roots will not store well.

To prevent problems with boron deficiency, apply soluble boron (ie. Solubor or borax). Be careful during application as many crops are sensitive to boron. See Table 10 and Table 11 for crop sensitivity and tolerance levels. Drift will cause leaves of sensitive crops to be burned and growth damaged. Residue in the soil can also cause problems the following season in sensitive crops.

A general rate for Solubor (20% boron) would be 20 grams per 30 meters of row in approximately 10 liters of water (for crops with a high requirement for boron). Borax (10% boron), would have to be applied at twice this rate (40 grams per 30 meters of row). This application could be made to the row before planting or drenched on the row 5 weeks after planting. An alternative method of application would be to split the application — apply drenches 4 weeks and 6 weeks after planting. This will help to avoid toxicity problems.

Common Disease Problems

EARLY BLIGHT

Early blight is an annual problem of tomatoes and potatoes in the home gardens of Atlantic Canada.

It is somewhat misnamed as it can appear in the garden at any time and is usually found around mid-August (especially as tops begin to mature). It is a foliar disease caused by the fungus *Alternaria solani*. Lesions appear first on older leaves and stems as small, circular or oval brown to black spots that gradually enlarge. Concentric rings can often be seen within the enlarged lesions. The disease is more severe during periods of warm, humid weather and defoliation can become a problem. Damage on tomato fruit will appear as large, sunken areas particularly at the calyx end or on growth cracks.

The fungus overwinters on diseased plant debris. Complete removal of crop debris will reduce overwintering of the fungus. Healthy, vigorous plants are less susceptible to injury from early blight. Be sure to supply adequate fertilizer and water to maintain even growth. Well spaced plants with sufficient air movement are also less susceptible to infection.

LATE BLIGHT

Late Blight is a serious disease of potatoes and tomatoes in Atlantic Canada. It is caused by the fungus *Phytophthora infestans* which overwinters on infected tubers and is more of a problem during periods of humid weather during July, August and September.

Symptoms appear first as brownish-black, water-soaked blotches on the leaves. Under favorable conditions, the disease will spread rapidly through the foliage causing complete defoliation. Foliar symptoms are on both potatoes and tomatoes.

For early maturing potato varieties, late blight will not seriously affect crop development or yield as the tubers will be developed before defoliation occurs. Later maturing varieties may require applications of a fungicide to prevent complete defoliation and to avoid being a source of contamination to neighboring commercial fields.

Infection on tomato fruit appears as rough, greasy, greenish-brown patches. When taken inside to ripen, they remain firm but will turn brown and leathery.

To reduce the incidence of late blight, begin the gardening season with clean seed potatoes. Plant only certified seed potatoes to prevent introductions into your garden. Do not use seed saved from the previous garden season. Introduction on tomato seed or plant tissue (from a greenhouse) is not a problem.

Grow early maturing varieties and maintain vigorous growth throughout the season. Water the garden early in the day and provide adequate space between plants to ensure good air drainage. Practice good garden sanitation (remove tubers) to prevent overwintering of the disease organism. If the disease is present on the potato crop, careful harvesting can avoid infection of the tubers. To accomplish this, remove all tops from the garden area and wait two weeks before harvesting. The two week period will kill the spores on the soil surface which could infect the tubers at harvest time. Affected tubers will rot in storage or will act as an infection source for next year.

CLUBROOT

Clubroot is a serious soil-borne disease of all the cole crops as well as turnips and rutabagas. It is caused by several strains of the soil-borne fungus organism *Plasmodiophora brassicae*. The organism can remain in the soil for a number of years without its host crop(s), and cannot be eradicated from infected soil. It is spread by diseased tissue or soil, and on equipment or tools which move from one site to another.

Clubroot appears as small or large club-like swellings on the roots. The swellings affect translocation of water and nutrients from the root zone. The plants will take on a bluish tinge and growth will be stunted. In severe infestations, the entire root system will be deformed and the foliage will turn yellow and wilt in the warm sunny weather.

Clubroot infestation is greater in acid soil conditions. A soil pH maintained as close to 7 as possible with limestone can reduce the incidence of the disease. Soil conditions with a pH level of below 7 but with high concentrations of calcium and magnesium will also control disease development. To slow down the build-up of the disease, maintain a crop rotation using crucifer crops once every 4-7 years. Several of the common weed species are also susceptible to clubroot and therefore help to maintain the presence of the organism in the soil. Try to maintain good weed control in the garden. Susceptible weeds include wild mustard, wild radish, shepard's purse, worm seed mustard, and yellow rocket. Do not put infected tissue in the compost pile.

DAMPING OFF

Damping off is a soil-borne disease problem of seedlings caused by the fungal organisms *Rhizoctonia, Pythium* and *Phytophthora*. It is a problem in the greenhouse, in cold frames, and if unsterilized garden soil or unsterilized flats or tools are used for seedling production. The fungi attack the seedlings before they emerge causing death. Seedlings can also be attacked at the soil surface after emergence. Damage appears as sunken areas on the stem at the soil line. Plants usually topple over and die. Plants can survive initial attack but will carry a scar. Affected plants will not thrive and should be discarded.

Wet soil conditions promote disease development. Water lightly and only as frequently as needed. Sow seeds thinly and cover lightly with soil. Thin thickly planted seedlings after emergence to prevent crowding. Provide good air circulation and fertilize transplants to promote good growth. The disease is most

serious early in the season during periods of cool, damp weather conditions.

Use sterilized mixes available from garden centers. If garden soil is used in the mix, sterilize in the oven. Place shallow layers of soil in metal containers in the oven for 1 hour at a temperature of 82°C. Sterilize planting containers with a solution of 1 part, 6% bleach in 9 parts water. Rinse containers after treatment. Preventative soil drenches are available commercially and can be used after seeding or after emergence.

ANTHRACNOSE

Anthracnose, a disease caused by the fungus *Colletotrichum*, is a problem to a number of crops. In the home garden, beans and tomatoes are most severely affected.

On beans, the fungus appears as sunken lesions on the pods and stems. During periods of moist weather, the lesions will be covered with a salmon colored ooze.

On tomatoes, the disease affects the fruit causing sunken, circular areas on the ripening fruit. As the disease develops, the spots expand in size and usually spoil the fruit.

The disease spores overwinter in the soil, on the seed and on infected debris and is promoted by cool, wet conditions and high humidity. It can spread by wind, rain, animals and humans and on implements. To reduce the incidence of anthracnose, use proper plant spacings to provide good air movement around the plants and avoid handling susceptible crops when the foliage is wet.

WHITE MOLD, GRAY MOLD

Many vegetable crops are affected by the fungi organisms which cause white and gray mold disease.

White mold which is caused by the fungal organism *Sclerotinia* can affect almost all vegetable crops but is most frequently found on beans, head lettuce, cabbage and carrots.

In beans, the disease appears first as soft, watery spots on the pods, stems, or leaves and is most serious in periods of wet, weather conditions. As the disease progresses, a white, fuzzy growth develops on the infected tissue. Small, hard, black structures appear on the fuzzy, growth. These structures act as the source of infection for next year.

In cabbage and head lettuce, the disease begins as a water soaked area on the stem near the soil line. As it progresses upward, the leaves wither, die and drop to the soil. The head becomes wet and slimy. In moist weather, the white, fuzzy growth develops. Later, the hard, black overwintering structures develop.

Although *Sclerotinia* rot is more serious as a storage disease of carrots, some damage can occur to the foliage during the growing season. Foliar damage begins at the base of the leafstalk causing the stalk to turn brown and die. In storage, a white cottony growth appears on the root. The infected tissue becomes soft and watery and breaks down. The disease can spread quickly to other roots and is more serious when storage temperatures are above 0°C.

Gray mold, which is caused by the fungal organism *Botrytis*, can also affect a number of vegetable crops but is most serious in beans, onions, and tomatoes.

In beans, the symptoms are similar to that of white mold except that a gray-brown growth develops on the infected tissues.

Two problems of onions, leaf blight and neck rot, are caused by the *Botrytis* organism. Leaf blight occurs during the growing season as white specks on the foliage. As the disease expands, the leaves turn brown from the tips downward and die. Under ideal conditions (moist), the foliage can die within a week. Neck rot is a problem in storage. The onions may appear fine at harvest. However, in storage the neck area of the bulb will shrivel and the tissue will be soft and brownish. A gray, powdery mold will appear in the tissue and hard, black pea-like structures may develop. Usually, other organisms will enter and cause a very soft rot.

In tomatoes, ghost spot is caused by the *Botrytis* organism. Ghost spot does not cause serious damage to the fruit. It appears as small, whitish rings or spots on the surface of tomatoes. The rings are caused when the disease organism enters the surface tissue of the fruit but is killed by high temperatures.

As the diseases caused by both *Sclerotinia* and *Botrytis* are more serious during periods of high moisture, their incidence can be reduced through cultural means. Provide adequate spacing between rows and within the row to enable foliage to dry quickly. Avoid excessive amounts of nitrogen fertilizer to reduce lush plant growth. Stay away from the garden when the foliage is wet and avoid prolonged periods of sprinkling. If possible, when watering, apply the water to the ground. Remove affected plants or plant parts as soon as they appear but do not put the plants in the compost pile. Remove plant debris in the fall to prevent overwintering. Use crop rotation. To reduce storage loss in carrots, harvest carefully to avoid bruising. Remove as much soil as possible from the roots, store only healthy roots and store under appropriate conditions.

POWDERY MILDEW

Powdery mildew is a fungal disease of several vegetable crops but is most serious in the home garden on cucumbers, squash, pumpkins, melons and peas. It is a foliar disease which causes a white talcumlike powdery growth on the upper surface of the leaf. Affected leaves will wither, turn color, become brittle, dry, and die.

The disease can overwinter on plant debris or can be introduced by wind during the growing season. Although it can occur during periods of either cool or warm humid weather conditions, it is more common and serious in warm, dry weather conditions. Once established, it can spread rapidly to uninfected plants.

To reduce the incidence of powdery mildew, remove crop debris after harvest. Provide adequate spacing between rows and between plants to allow good air movement. Maintain good weed control in the garden to reduce the presence of susceptible weed species. Use resistant varieties where possible.

DOWNY MILDEW

Downy mildew is a foliar disease caused by several fungal organisms which affects vine crops, cole crops, turnips and rutabagas and onions. In cole crops and vine crops the disease appears first as pale green to yellow angular shaped spots on the upper surface of the leaf. As the disease progresses, the spots enlarge, become more yellow, and dry up. The leaves may drop off. In moist weather, a downy white to pale purple growth appears on the underside of the leaf corresponding to the leaf spot located on the upper surface. Black, sunken areas can occur on the heads of cabbage and cauliflower. In onions, similar leaf spots develop but are covered, with a fuzzy purplish growth.

Downy mildew can overwinter in debris in the garden, on seed or sets (onions), or be introduced by wind into the garden. While the disease is most serious in cole crops during periods of cool, wet weather conditions, periods of warm, wet weather conditions favor disease development in vine crops and onions. Disease spores can be spread by splashing water, on tools or clothing or by the wind. To reduce the incidence of downy mildew, remove crop debris immediately after harvest. Provide adequate spacing to allow air movement around plants. Separate susceptible crops to slow down disease spread. Use resistant varieties where possible.

SCAB

Scab is a soil-borne disease of potatoes, beets, rutabagas, and radish caused by the fungus *Streptomyces scabies*. In all crops, the root or tuber area of the plant is affected. The disease organism enters the root or tuber through wounds or naturally occurring openings. It causes rough, corky, raised or sunken patches or pits on the root surface. Potato tuber growth is not affected. The roots of other susceptible crops may become somewhat misshapen. Leaves and stems are not affected.

Scab, like clubroot, can persist in the soil for many years. It is more of a problem when the soil pH is 5.3 or greater and is therefore more serious when lime or wood ash is applied to the soil. Do not apply large volumes of fresh manure or use manures that contain sawdust, wood shavings or wood chips and do not use these as mulches as high volumes of fresh organic matter appears to aggravate the scab disease. Limestone may be used with scab tolerant varieties but it should be applied in the fall prior to planting. Irrigation, applied at the time of tuber initiation (flowering) to maintain an even soil moisture content will reduce the incidence of disease. Infected potato seed pieces can introduce the disease to the soil. To reduce disease incidence, plant susceptible crops on a three year rotation. Use certified seed potatoes. Plant resistant varieties. Potato varieties with resistance include *"Superior", "Russet Burbank", "Belleisle", "Chieftain", "Russet Norkotah" and "Sebago"*.

A Key to Identify the Adult Stage of Insect Pests Found on Vegetables

*A1. Four pairs of legs present; very small, less than 1mm in length.
....Spider Mites

Three pairs of legs present; size variable.
....Insects 2

A2. Wings present.
....Adults 3

Fully developed wings absent; wing pads may be present in some individuals.
....Larva; see key to larvae.

A3. Mouthparts adapted for piercing and sucking. (Figure 2)
....4

Mouthparts adapted for chewing and biting. (Figure 3)
....7

A4. Larger insects, 4mm. or more in length; wings folded flat over the back. Front half of the wings leathery, back half of the wings membranous.
....5

Small insects less than 4mm. in length; wings if present folded tentlike over the back, or, if folded flat over the back, wings are featherlike. (Figure 4)
....6

A5. Body shield shaped; antennae with 5 segments; often giving off strong odour.
....Stink Bugs

Body narrower, elongate; antenae with 4 segments; fast moving, do not give off odour.
....Tarnished Plant Bug

A6. Wings completely membranous, folded tentlike over the body. (Figure 5)
....Aphids

Wings featherlike, folded flat over the body. (Figure 4)
....Onion Thrips

A7. Abdomen with a pair of large forceps or pincers at the tip.
....European Earwig

Abdomen lacking pincers.
....8

A8. Antenna shorter than the length of the head and thorax; distinctly clubbed. (Figure 6) Dome shaped or oval beetles.
....Lady Beetles

Antenna as long or longer than the length of the head and thorax; not distinctly clubbed. (Figure 7) Shape and size variable.
....9

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* A refers to adult insect key

Figure 1: Adult Insect

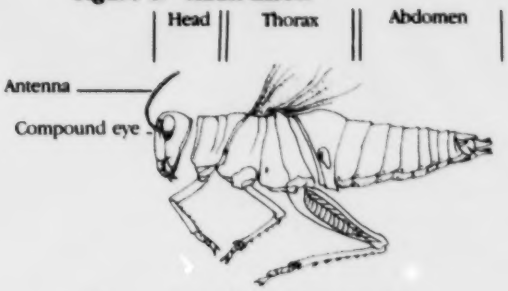

Figure 2: Sucking Mouthparts

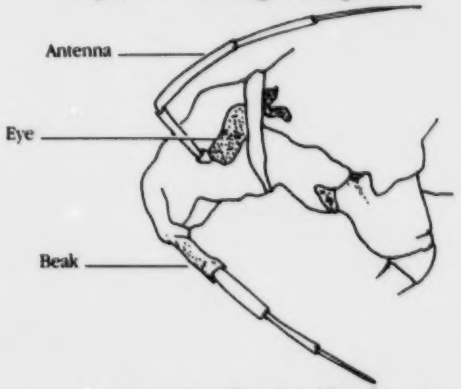

Figure 3: Chewing Mouthparts

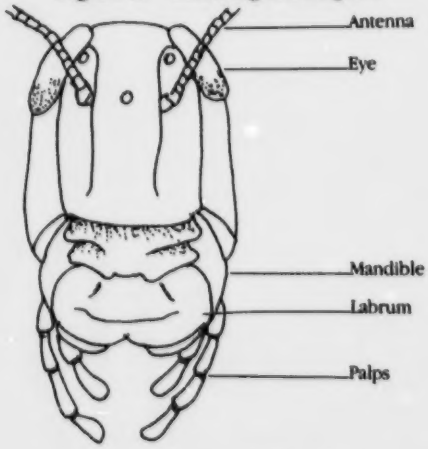

Figure 4: Thrips (Adult)

A9. Thorax narrower than the head, and wings. Wing covers, soft, usually gray.

....Blister Beetles

Thorax wider than head; wing covers hard, colours variable.

....10

A10. Feet with five segments; (Figure 8) jaws pointing forward; fast moving beetles. Usually seen on the ground.

....Ground Beetles

Feet with four segments; (Figure 9) jaws pointing downward; usually found on the plant.

....11

A11. Small black or metallic coloured beetles, hind legs thickened to enable them to jump.

....Flea Beetles

Small to medium sized beetles with a striped or spotted pattern; hind legs not modified for jumping.

....12

A12. Wing covers striped.

....13

Wing covers spotted, or with bars. Found on asparagus.

....14

A13. Robust yellowish beetle with three or more black stripes on each wing cover.

....Colorado Potato Beetle

More slender beetles, wing covers black with a yellow stripe. Feeds on cucurbits.

....Striped Cucumber Beetle

A14. Wing covers metallic blue with yellow spots or bars.

....Asparagus Beetle

Wing covers red with black spots.

....Spotted Asparagus Beetle

How to use a key:

- Start at No. 1.
- You are always given two choices to select from.
- Follow numbers given in the choice that best describes your insect.
- e.g. A1 — A2 — A3 — A4 — A6 — Aphid

Figure 5: Aphid Adult

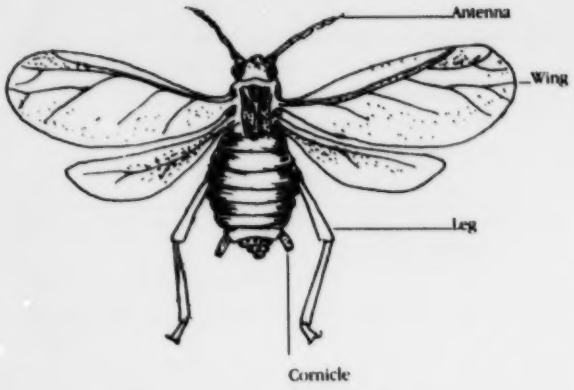

Figure 6: Clubbed Antenna

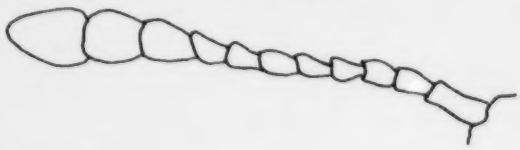

Figure 7: Antenna Not Clubbed

Figure 8: Foot with 5 segments

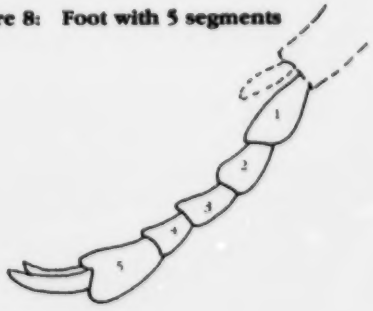

Figure 9: Foot with 4 segments

A Key to Identify the Larva of Insect Pests Found on Vegetables

*L1. Mouthparts adapted for piercing and sucking; wingpads may be present. (Figure 10)
....2

Mouthparts adapted for chewing or biting; wingpads never present. (Figure 3)
....3

L2. Body slender, tapering to a point; very small. (Figure 4)
Thrips

Body more less oval or pearshaped. (Figure 10)
Aphids

L3. Legs absent; found on roots or seeds planted in the ground.
Root maggots

Legs present.
....4

L4. Legs present on first three segments behind head only. (Figure 11)
....5

Legs present on two or more abdominal segments in addition to the legs on the first three segments. (Figure 12)
....8

L5. Found in the soil, feeding on the roots or tubers.
....6

Found on the aboveground portion of the plant.
....7

L6. 'C' shaped larva, white in color with a brown head.
White Grub

Slender golden yellow larva, very tough skinned.
Wireworm

L7. Rounded, smooth skinned, reddish brown larva.
Colorado Potato Beetle

Tapered slender, skin warty, colored with patches of blue, black, and orange.
Lady Beetle

L8. Two pairs of prolegs present, moves with looping motion.
Cabbage Looper

More than two pairs of prolegs present.
....9

L9. Larva found in stem or stalk of various vegetables.
....10

Larva found feeding on leaves or other plant parts.
....11

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*L refers to the larvae insect key

Figure 10: Aphid Nymph

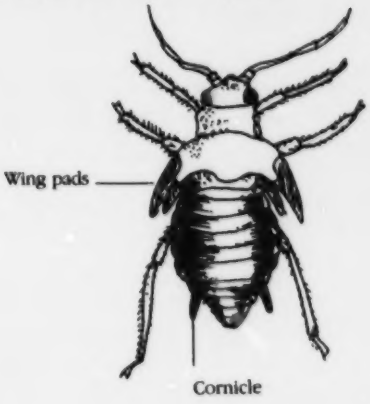


Figure 11: Grub

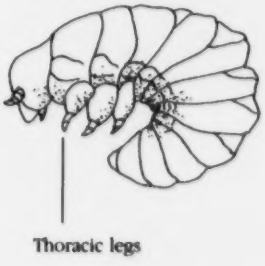
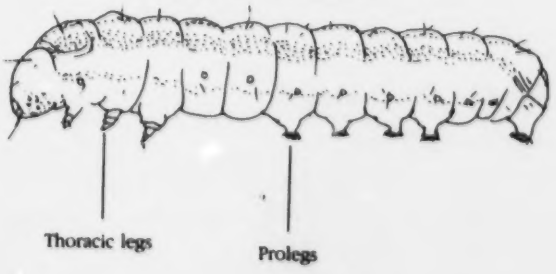


Figure 12: Caterpillar



L10. Larva pink with dark bands across body, occurs in June-early July.

Potato Stem Borer

Larva flesh colored with round, brow spots, occurs in later July and August.

European Corn Borer

L11. Larva found in soil near base of plants during the day; coil into a 'C' shape when disturbed.

Cutworms

Larva found on the plant during the day. Various reactions when disturbed.

....12

L12. Larva found on cabbage and related crops.

....13

Larva usually found in ears of corn but may be found on other crops.

....15

L13. Larva with purple color on back.

Purple-backed Cabbageworm

Larva green in color.

....14

L14. Larva velvety in appearence with pale green stripe down midline. Very sluggish when disturbed.

Imported Cabbageworm

Larva small, tapered at ends, pale green in color, wriggles rapidly when disturbed or may fall from plant on silk thread.

Diamondback Moth

L15. Head capsule dark with inverted 'Y' on front of head. (Figure 13)

Fall Armyworm

Head capsule light brown, no 'Y' marking on head. (Figure 14)

Corn earworm

Figure 13: Fall Armyworm

Figure 14: Corn Earworm

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